

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

THE EPHEMERIS

1986

Prepared by
Nautical Almanac Office
United States Naval Observatory

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1986

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT



EPHEMERIS OF THE SUN, POLARIS
AND
OTHER SELECTED STARS
WITH COMPANION DATA AND TABLES
FOR THE YEAR
1986

A Supplement to the Manual of Instruction for the Survey of the Public Lands
of the United States

SEVENTY-SEVENTH EDITION

Prepared by Nautical Almanac Office
United States Naval Observatory



UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON : 1985

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PREFACE

The arrangement of the astronomical data herein conforms to the methods and examples for the determination of time, latitude, and azimuth, practiced by the cadastral engineers of the Bureau of Land Management. These practices are described in the Manual of Instructions for the Survey of the Public Lands of the United States.

The methods long in use have been developed for the best operation of the improved solar transit, in combination with observations on the sun, Polaris, and the brighter equatorial stars, for the determination and verification of time, latitude, and azimuth. In this practice, the data for the *sun* are required in terms of daily *apparent positions* for the Greenwich meridian; for all *stellar* positions in terms of the Greenwich meridian, *mean time*, and *mean time intervals*.

The apparent time of sunrise and of sunset, the refractions in polar distance, and the companion trigonometric tables and formulas employed in these methods, are tabulated in the Standard Field Tables of the Bureau of Land Management.

Other Technical Publications

The Superintendent of Documents, Government Printing Office, Washington, D.C. 20402, has for sale to the public at current cost of printing the following technical publications of the Bureau of Land Management.

The Manual of Instructions for the Survey of the Public Lands of the United States, 1973.

Standard Field Tables, 1956 (a supplement to the Manual of Surveying Instructions); contains traverse tables; stadia coefficients; 5-place natural and 6-place logarithmic sines, cosines, tangents, and cotangents; 6-place logarithms of numbers; and other tables and data of particular application in land surveying practice.

The Ephemeris, published annually.

Restoration of Lost or Obliterated Corners and Subdivisions of Sections, 1963 edition, reprint 1965; a compendium of the rules that are applicable within the area of the United States rectangular surveys, for the guidance of county and other local surveyors, with explanation of the methods relating to retracements.

AT GREENWICH APPARENT NOON						POLARIS FOR THE MERIDIAN OF GREENWICH, CIVIL DATE AND MEAN TIME			
Date	THE SUN'S			Time Semi- diam- eter Pass- ing Mer.	Equation of Time, Add to Apparent Time	Upper Cul- mination	Elongation Lat. 40°	Decli- nation	
	Apparent Declination	Diff. for 1 Hour	Semi- diam- eter						
J A N U A R Y , 1 9 8 6									
		° ' "	"	' "	s	m s	h m P.M.	h m A.M.	+89° ' "
Wed.	1	S23 00 19.3	+12.35	16 17.52	71	3 30.32	7 32.8 P.M.	W.E. 1 33.1 A.M.	12 24.03
Thur.	2	22 55 09.1	13.50	16 17.53	71	3 58.47	7 28.8	1 29.1	12 24.20
Fri.	3	22 49 31.4	14.64	16 17.52	71	4 26.29	7 24.9	1 25.2	12 24.35
Sat.	4	22 43 26.4	15.77	16 17.51	71	4 53.75	7 20.9	1 21.2	12 24.49
Sun.	5	22 36 54.4	16.90	16 17.50	71	5 20.83	7 17.0	1 17.3	12 24.63
Mon.	6	22 29 55.4	18.01	16 17.48	71	5 47.49	7 13.0	1 13.3	12 24.78
Tues.	7	22 22 29.7	19.12	16 17.46	71	6 13.71	7 09.1	1 09.4	12 24.94
Wed.	8	22 14 37.5	20.22	16 17.43	71	6 39.46	7 05.1	1 05.4	12 25.13
Thur.	9	22 06 19.0	21.31	16 17.40	71	7 04.69	7 01.2	1 01.5	12 25.33
Fri.	10	21 57 34.6	22.39	16 17.36	70	7 29.39	6 57.2	0 57.5	12 25.53
Sat.	11	21 48 24.4	23.46	16 17.33	70	7 53.51	6 53.2	0 53.6	12 25.72
Sun.	12	21 38 48.7	24.51	16 17.28	70	8 17.04	6 49.3	0 49.6	12 25.88
Mon.	13	21 28 47.8	25.55	16 17.24	70	8 39.95	6 45.3	0 45.6	12 26.02
Tues.	14	21 18 22.1	26.59	16 17.19	70	9 02.21	6 41.4	0 41.7	12 26.13
Wed.	15	21 07 31.7	27.60	16 17.14	70	9 23.80	6 37.4	0 37.7	12 26.21
Thur.	16	20 56 17.1	28.61	16 17.08	70	9 44.69	6 33.4	0 33.8	12 26.28
Fri.	17	20 44 38.5	29.60	16 17.02	70	10 04.88	6 29.5	0 29.8	12 26.34
Sat.	18	20 32 36.2	30.58	16 16.95	70	10 24.35	6 25.5	0 25.8	12 26.39
Sun.	19	20 20 10.7	31.54	16 16.88	70	10 43.07	6 21.6	0 21.9	12 26.44
Mon.	20	20 07 22.3	32.49	16 16.80	70	11 01.05	6 17.6	0 17.9	12 26.50
Tues.	21	19 54 11.3	33.42	16 16.72	69	11 18.26	6 13.7	0 14.0	12 26.57
Wed.	22	19 40 38.1	34.34	16 16.63	69	11 34.69	6 09.7	0 10.0	12 26.65
Thur.	23	19 26 43.1	35.24	16 16.54	69	11 50.34	6 05.8	0 06.1	12 26.73
Fri.	24	19 12 26.6	36.13	16 16.44	69	12 05.20	6 01.8	{ 0 02.1 A.M. 11 58.2 P.M. }	12 26.82
Sat.	25	18 57 49.0	37.00	16 16.33	69	12 19.27	5 57.8	11 54.2	12 26.91
Sun.	26	18 42 50.6	37.86	16 16.22	69	12 32.53	5 53.9	11 50.2	12 26.98
Mon.	27	18 27 31.9	38.70	16 16.10	69	12 45.00	5 49.9	11 46.3	12 27.04
Tues.	28	18 11 53.1	39.52	16 15.98	69	12 56.66	5 46.0	11 42.3	12 27.07
Wed.	29	17 55 54.8	40.33	16 15.85	69	13 07.53	5 42.0	11 38.4	12 27.08
Thur.	30	17 39 37.1	41.13	16 15.71	68	13 17.59	5 38.0	11 34.4	12 27.06
Fri.	31	S17 23 00.5	+41.91	16 15.57	68	13 26.86	5 34.1 P.M.	W.E. 11 30.4 P.M.	12 27.03
F E B R U A R Y , 1 9 8 6									
Sat.	1	S17 06 05.4	+42.68	16 15.43	68	13 35.32	5 30.1 P.M.	W.E. 11 26.5 P.M.	12 26.99
Sun.	2	16 48 52.1	43.42	16 15.28	68	13 42.99	5 26.2	11 22.5	12 26.95
Mon.	3	16 31 21.1	44.15	16 15.13	68	13 49.87	5 22.2	11 18.6	12 26.93
Tues.	4	16 13 32.7	44.87	16 14.97	68	13 55.95	5 18.3	11 14.6	12 26.93
Wed.	5	15 55 27.4	45.56	16 14.81	68	14 01.24	5 14.3	11 10.7	12 26.94
Thur.	6	15 37 05.6	46.24	16 14.64	68	14 05.73	5 10.4	11 06.7	12 26.96
Fri.	7	15 18 27.7	46.90	16 14.48	68	14 09.42	5 06.4	11 02.8	12 26.98
Sat.	8	14 59 34.2	47.55	16 14.31	67	14 12.33	5 02.4	10 58.8	12 26.97
Sun.	9	14 40 25.5	48.17	16 14.14	67	14 14.44	4 58.5	10 54.8	12 26.95
Mon.	10	14 21 02.0	48.78	16 13.96	67	14 15.77	4 54.5	10 50.9	12 26.89
Tues.	11	14 01 24.3	49.36	16 13.78	67	14 16.32	4 50.6	10 46.9	12 26.80
Wed.	12	13 41 32.6	49.93	16 13.60	67	14 16.08	4 46.6	10 43.0	12 26.70
Thur.	13	13 21 27.5	50.49	16 13.42	67	14 15.08	4 42.6	10 39.0	12 26.58
Fri.	14	13 01 09.3	51.02	16 13.24	67	14 13.32	4 38.7	10 35.0	12 26.45
Sat.	15	12 40 38.5	51.53	16 13.05	67	14 10.80	4 34.7	10 31.1	12 26.32
Sun.	16	S12 19 55.6	+52.03	16 12.86	67	14 07.54	4 30.8 P.M.	W.E. 10 27.1 P.M.	12 26.20

The sign + prefixed to the hourly change of declination indicates that { north } declinations are { increasing. }
south } { decreasing. }

AT GREENWICH APPARENT NOON								POLARIS FOR THE MERIDIAN OF GREENWICH, CIVIL DATE AND MEAN TIME			
Date	THE SUN'S			Time Semi- diam- eter Pass- ing Mer.	Equation of Time, Add to Apparent Time	Upper Cul- mination	Elongation Lat. 40°	Decli- nation			
	Apparent Declination	Diff. for 1 Hour	Semi- diam- eter								
F E B R U A R Y , 1 9 8 6											
		° ' "	"	' "	s	m s	h m P.M.	h m P.M.	+89° ' "		
Sun.	16	S 12 19 55.6	+52.03	16 12.86	67	14 07.54	4 30.8 P.M.	W.E. 10 27.1 P.M.	12 26.20		
Mon.	17	11 59 01.0	52.51	16 12.66	66	14 03.56	4 26.8	10 23.2	12 26.09		
Tues.	18	11 37 55.0	52.98	16 12.46	66	13 58.86	4 22.9	10 19.2	12 25.98		
Wed.	19	11 16 38.2	53.42	16 12.26	66	13 53.46	4 18.9	10 15.3	12 25.89		
Thur.	20	10 55 10.9	53.85	16 12.05	66	13 47.37	4 15.0	10 11.3	12 25.80		
Fri.	21	10 33 33.5	54.26	16 11.84	66	13 40.61	4 11.0	10 07.4	12 25.71		
Sat.	22	10 11 46.5	54.65	16 11.63	66	13 33.20	4 07.0	10 03.4	12 25.62		
Sun.	23	9 49 50.2	55.03	16 11.41	66	13 25.15	4 03.1	9 59.5	12 25.51		
Mon.	24	9 27 45.0	55.39	16 11.19	66	13 16.49	3 59.1	9 55.5	12 25.38		
Tues.	25	9 05 31.4	55.74	16 10.96	66	13 07.23	3 55.2	9 51.5	12 25.22		
Wed.	26	8 43 09.6	56.07	16 10.73	66	12 57.41	3 51.2	9 47.6	12 25.04		
Thur.	27	8 20 40.0	56.39	16 10.49	66	12 47.03	3 47.3	9 43.6	12 24.84		
Fri.	28	S 7 58 03.1	+56.69	16 10.25	65	12 36.12	3 43.3 P.M.	W.E. 9 39.7 P.M.	12 24.64		
M A R C H , 1 9 8 6											
Sat.	1	S 7 35 19.0	+56.97	16 10.01	65	12 24.70	3 39.4 P.M.	W.E. 9 35.7 P.M.	12 24.43		
Sun.	2	7 12 28.3	57.24	16 09.76	65	12 12.79	3 35.4	9 31.8	12 24.24		
Mon.	3	6 49 31.4	57.50	16 09.52	65	12 00.41	3 31.5	9 27.8	12 24.07		
Tues.	4	6 26 28.5	57.74	16 09.26	65	11 47.58	3 27.5	9 23.9	12 23.92		
Wed.	5	6 03 20.1	57.96	16 09.01	65	11 34.31	3 23.6	9 19.9	12 23.77		
Thur.	6	5 40 06.6	58.16	16 08.76	65	11 20.63	3 19.6	9 16.0	12 23.63		
Fri.	7	5 16 48.4	58.35	16 08.50	65	11 06.54	3 15.7	9 12.0	12 23.47		
Sat.	8	4 53 25.9	58.52	16 08.24	65	10 52.07	3 11.7	9 08.1	12 23.29		
Sun.	9	4 29 59.5	58.67	16 07.99	65	10 37.24	3 07.7	9 04.1	12 23.09		
Mon.	10	4 06 29.7	58.81	16 07.73	65	10 22.05	3 03.8	9 00.2	12 22.86		
Tues.	11	3 42 56.8	58.93	16 07.47	65	10 06.53	2 59.8	8 56.2	12 22.61		
Wed.	12	3 19 21.3	59.03	16 07.21	65	9 50.69	2 55.9	8 52.3	12 22.35		
Thur.	13	2 55 43.4	59.12	16 06.95	65	9 34.55	2 51.9	8 48.3	12 22.08		
Fri.	14	2 32 03.7	59.19	16 06.69	65	9 18.12	2 48.0	8 44.4	12 21.81		
Sat.	15	2 08 22.5	59.24	16 06.43	65	9 01.43	2 44.1	8 40.4	12 21.54		
Sun.	16	1 44 40.2	59.28	16 06.17	65	8 44.49	2 40.1	8 36.5	12 21.28		
Mon.	17	1 20 57.2	59.30	16 05.91	65	8 27.33	2 36.2	8 32.5	12 21.04		
Tues.	18	0 57 13.8	59.30	16 05.65	65	8 09.95	2 32.2	8 28.6	12 20.80		
Wed.	19	0 33 30.6	59.30	16 05.38	65	7 52.39	2 28.3	8 24.6	12 20.58		
Thur.	20	S 0 09 47.7	59.27	16 05.12	65	7 34.66	2 24.3	8 20.7	12 20.36		
Fri.	21	N 0 13 54.4	59.23	16 04.85	65	7 16.78	2 20.4	8 16.7	12 20.14		
Sat.	22	0 37 35.3	59.17	16 04.58	64	6 58.77	2 16.4	8 12.8	12 19.91		
Sun.	23	1 01 14.8	59.10	16 04.31	64	6 40.67	2 12.5	8 08.8	12 19.67		
Mon.	24	1 24 52.3	59.02	16 04.04	64	6 22.48	2 08.5	8 04.9	12 19.41		
Tues.	25	1 48 27.8	58.92	16 03.77	64	6 04.24	2 04.6	8 00.9	12 19.12		
Wed.	26	2 12 00.7	58.81	16 03.49	64	5 45.96	2 00.6	7 57.0	12 18.81		
Thur.	27	2 35 30.8	58.69	16 03.22	64	5 27.68	1 56.7	7 53.1	12 18.49		
Fri.	28	2 58 57.8	58.56	16 02.94	64	5 09.41	1 52.8	7 49.1	12 18.18		
Sat.	29	3 22 21.5	58.41	16 02.66	64	4 51.19	1 48.8	7 45.2	12 17.88		
Sun.	30	3 45 41.3	58.24	16 02.37	64	4 33.03	1 44.9	7 41.2	12 17.60		
Mon.	31	4 08 57.2	58.07	16 02.09	64	4 14.95	1 40.9	7 37.3	12 17.34		
Tues.	32	N 4 32 08.6	+57.88	16 01.81	64	3 56.98	1 37.0 P.M.	W.E. 7 33.4 P.M.	12 17.10		

The sign + prefixed to the hourly change of declination indicates that { north } declinations are { increasing.
south } { decreasing.

AT GREENWICH APPARENT NOON							POLARIS FOR THE MERIDIAN OF GREENWICH, CIVIL DATE AND MEAN TIME				
Date	THE SUN'S			Time Semi- diam- eter Pass- ing Mer.	Equation of Time, Add to Subtract from Apparent Time	Upper Cul- mination	Elongation Lat. 40°	Decli- nation			
	Apparent Declination	Diff. for 1 Hour	Semi- diam- eter								
A P R I L , 1 9 8 6											
Tues. 1	N 4 32 08.6	+57.88	16 01.81	64	3 56.98	1 37.0 P.M.	W.E. 7 33.4 P.M.	+89° 12 17.10			
Wed. 2	4 55 15.3	57.67	16 01.52	65	3 39.13	1 33.1	7 29.4	12 16.86			
Thur. 3	5 18 16.8	57.45	16 01.24	65	3 21.43	1 29.1	7 25.5	12 16.62			
Fri. 4	5 41 12.9	57.21	16 00.96	65	3 03.89	1 25.2	7 21.5	12 16.36			
Sat. 5	6 04 03.1	56.96	16 00.68	65	2 46.53	1 21.2	7 17.6	12 16.08			
Sun. 6	6 26 47.1	56.70	16 00.40	65	2 29.36	1 17.3	7 13.7	12 15.78			
Mon. 7	6 49 24.5	56.42	16 00.12	65	2 12.41	1 13.4	7 09.7	12 15.46			
Tues. 8	7 11 55.0	56.12	15 59.84	65	1 55.67	1 09.4	7 05.8	12 15.12			
Wed. 9	7 34 18.2	55.81	15 59.57	65	1 39.18	1 05.5	7 01.8	12 14.78			
Thur. 10	7 56 33.7	55.48	15 59.30	65	1 22.95	1 01.5	6 57.9	12 14.43			
Fri. 11	8 18 41.3	55.14	15 59.03	65	1 06.98	12 57.6	6 54.0	12 14.10			
Sat. 12	8 40 40.4	54.78	15 58.76	65	0 51.29	12 53.7	6 50.0	12 13.77			
Sun. 13	9 02 30.8	54.41	15 58.49	65	0 35.90	12 49.7	6 46.1	12 13.46			
Mon. 14	9 24 12.1	54.02	15 58.22	65	0 20.81	12 45.8	6 42.2	12 13.17			
Tues. 15	9 45 43.9	53.62	15 57.96	65	0 06.05	12 41.9	6 38.2	12 12.89			
Wed. 16	10 07 06.0	53.21	15 57.70	65	0 08.37	12 38.0	6 34.3	12 12.61			
Thur. 17	10 28 17.9	52.78	15 57.44	65	0 22.44	12 34.0	6 30.4	12 12.35			
Fri. 18	10 49 19.3	52.33	15 57.18	65	0 36.15	12 30.1	6 26.4	12 12.08			
Sat. 19	11 10 09.9	51.88	15 56.92	65	0 49.48	12 26.1	6 22.5	12 11.80			
Sun. 20	11 30 49.3	51.40	15 56.66	65	1 02.42	12 22.2	6 18.6	12 11.51			
Mon. 21	11 51 17.2	50.92	15 56.41	65	1 14.95	12 18.3	6 14.6	12 11.20			
Tues. 22	12 11 33.4	50.42	15 56.15	65	1 27.05	12 14.3	6 10.7	12 10.87			
Wed. 23	12 31 37.5	49.91	15 55.90	65	1 38.71	12 10.4	6 06.8	12 10.52			
Thur. 24	12 51 29.2	49.39	15 55.64	66	1 49.92	12 06.5	6 02.8	12 10.18			
Fri. 25	13 11 08.2	48.86	15 55.39	66	2 00.66	12 02.6 P.M.	W.E. 5 58.9 P.M.	12 09.85			
Sat. 26	13 30 34.3	48.31	15 55.13	66	2 10.91	11 58.6 A.M.	E.E. 6 02.3 A.M.	12 09.55			
Sun. 27	13 49 47.2	47.76	15 54.88	66	2 20.65	11 54.7	5 58.4	12 09.27			
Mon. 28	14 08 46.6	47.19	15 54.63	66	2 29.88	11 50.8	5 54.4	12 09.01			
Tues. 29	14 27 32.1	46.60	15 54.38	66	2 38.59	11 46.9	5 50.5	12 08.77			
Wed. 30	N14 46 03.4	+46.00	15 54.13	66	2 46.76	11 42.9 A.M.	E.E. 5 46.6 A.M.	12 08.53			
M A Y , 1 9 8 6											
Thur. 1	N15 04 20.3	+45.39	15 53.88	66	2 54.38	11 39.0 A.M.	E.E. 5 42.7 A.M.	12 08.27			
Fri. 2	15 22 22.4	44.77	15 53.63	66	3 01.44	11 35.1	5 38.7	12 08.00			
Sat. 3	15 40 09.3	44.13	15 53.39	66	3 07.94	11 31.1	5 34.8	12 07.71			
Sun. 4	15 57 40.7	43.48	15 53.15	66	3 13.88	11 27.2	5 30.9	12 07.40			
Mon. 5	16 14 56.3	42.81	15 52.91	66	3 19.25	11 23.3	5 26.9	12 07.08			
Tues. 6	16 31 55.7	42.13	15 52.68	66	3 24.04	11 19.4	5 23.0	12 06.75			
Wed. 7	16 48 38.7	41.44	15 52.45	67	3 28.26	11 15.4	5 19.1	12 06.43			
Thur. 8	17 05 04.9	40.74	15 52.23	67	3 31.91	11 11.5	5 15.2	12 06.11			
Fri. 9	17 21 14.0	40.02	15 52.01	67	3 34.99	11 07.6	5 11.3	12 05.80			
Sat. 10	17 37 05.7	39.28	15 51.79	67	3 37.50	11 03.7	5 07.3	12 05.51			
Sun. 11	17 52 39.7	38.54	15 51.58	67	3 39.44	10 59.8	5 03.4	12 05.24			
Mon. 12	18 07 55.6	37.78	15 51.37	67	3 40.81	10 55.8	4 59.5	12 04.98			
Tues. 13	18 22 53.2	37.01	15 51.16	67	3 41.62	10 51.9	4 55.6	12 04.74			
Wed. 14	18 37 32.2	36.23	15 50.96	67	3 41.87	10 48.0	4 51.7	12 04.51			
Thur. 15	18 51 52.2	35.43	15 50.76	67	3 41.57	10 44.1	4 47.7	12 04.28			
Fri. 16	N19 05 53.0	+34.63	15 50.57	67	3 40.72	10 40.2 A.M.	E.E. 4 43.8 A.M.	12 04.05			

The sign + prefixed to the hourly change of declination indicates that { north } declinations are { increasing. }
south } decreasing.

For time of Western Elongation of Polaris for any date after April 25th, add 5^h 56.4^m to the time of Upper Culmination of the same date.

AT GREENWICH APPARENT NOON							POLARIS FOR THE MERIDIAN OF GREENWICH, CIVIL DATE AND MEAN TIME				
Date	THE SUN'S			Time Semi- diam- eter Pass- ing Mer.	Equation of Time, Subtract from Add to Apparent Time	Upper Cul- mination	Elongation Lat. 40°	Decli- nation			
	Apparent Declination	Diff. for 1 Hour	Semi- diam- eter								
M A Y , 1 9 8 6											
		° ' "	"	' "	s	m s	h m A.M.	E.E. h m A.M.	+89° ' "		
Fri. 16	N19 05 53.0		+34.63	15 50.57	67	3 40.72	10 40.2 A.M.	4 43.8 A.M.	12 04.05		
Sat. 17	19 19 34.3		33.81	15 50.37	67	3 39.32	10 36.2	4 39.9	12 03.80		
Sun. 18	19 32 55.9		32.98	15 50.19	67	3 37.39	10 32.3	4 36.0	12 03.55		
Mon. 19	19 45 57.4		32.14	15 50.00	67	3 34.92	10 28.4	4 32.1	12 03.28		
Tues. 20	19 58 38.7		31.29	15 49.82	68	3 31.92	10 24.5	4 28.1	12 03.00		
Wed. 21	20 10 59.4		30.43	15 49.64	68	3 28.39	10 20.6	4 24.2	12 02.71		
Thur. 22	20 22 59.4		29.56	15 49.46	68	3 24.34	10 16.6	4 20.3	12 02.43		
Fri. 23	20 34 38.5		28.69	15 49.28	68	3 19.77	10 12.7	4 16.4	12 02.17		
Sat. 24	20 45 56.4		27.80	15 49.11	68	3 14.69	10 08.8	4 12.5	12 01.94		
Sun. 25	20 56 53.0		26.91	15 48.94	68	3 09.10	10 04.9	4 08.6	12 01.75		
Mon. 26	21 07 28.1		26.01	15 48.77	68	3 03.01	10 01.0	4 04.7	12 01.57		
Tues. 27	21 17 41.3		25.10	15 48.60	68	2 56.42	9 57.1	4 00.7	12 01.41		
Wed. 28	21 27 32.6		24.17	15 48.43	68	2 49.35	9 53.2	3 56.8	12 01.24		
Thur. 29	21 37 01.7		23.24	15 48.27	68	2 41.80	9 49.2	3 52.9	12 01.05		
Fri. 30	21 46 08.4		22.31	15 48.11	68	2 33.78	9 45.3	3 49.0	12 00.85		
Sat. 31	N21 54 52.4		+21.36	15 47.96	68	2 25.31	9 41.4 A.M.	E.E. 3 45.1 A.M.	12 00.63		
J U N E , 1 9 8 6											
Sun. 1	N22 03 13.6		+20.40	15 47.81	68	2 16.41	9 37.5 A.M.	E.E. 3 41.2 A.M.	12 00.40		
Mon. 2	22 11 11.7		19.44	15 47.66	68	2 07.09	9 33.6	3 37.2	12 00.15		
Tues. 3	22 18 46.7		18.47	15 47.52	68	1 57.37	9 29.7	3 33.3	11 59.91		
Wed. 4	22 25 58.2		17.49	15 47.39	69	1 47.28	9 25.8	3 29.4	11 59.68		
Thur. 5	22 32 46.2		16.51	15 47.25	69	1 36.82	9 21.8	3 25.5	11 59.46		
Fri. 6	22 39 10.6		15.52	15 47.13	69	1 26.03	9 17.9	3 21.6	11 59.26		
Sat. 7	22 45 11.0		14.52	15 47.01	69	1 14.93	9 14.0	3 17.7	11 59.08		
Sun. 8	22 50 47.5		13.52	15 46.89	69	1 03.54	9 10.1	3 13.8	11 58.92		
Mon. 9	22 55 59.8		12.51	15 46.78	69	0 51.88	9 06.2	3 09.9	11 58.77		
Tues. 10	23 00 48.0		11.50	15 46.67	69	0 39.99	9 02.3	3 06.0	11 58.64		
Wed. 11	23 05 11.7		10.48	15 46.57	69	0 27.87	8 58.4	3 02.0	11 58.51		
Thur. 12	23 09 11.1		9.46	15 46.48	69	0 15.57	8 54.5	2 58.1	11 58.38		
Fri. 13	23 12 45.9		8.44	15 46.39	69	0 03.09	8 50.6	2 54.2	11 58.25		
Sat. 14	23 15 56.1		7.41	15 46.30	69	0 09.52	8 46.6	2 50.3	11 58.11		
Sun. 15	23 18 41.6		6.38	15 46.22	69	0 22.25	8 42.7	2 46.4	11 57.95		
Mon. 16	23 21 02.3		5.35	15 46.14	69	0 35.08	8 38.8	2 42.5	11 57.78		
Tues. 17	23 22 58.4		4.32	15 46.07	69	0 47.97	8 34.9	2 38.6	11 57.61		
Wed. 18	23 24 29.6		3.28	15 46.00	69	1 00.91	8 31.0	2 34.7	11 57.44		
Thur. 19	23 25 36.0		2.25	15 45.93	69	1 13.89	8 27.1	2 30.8	11 57.29		
Fri. 20	23 26 17.7		1.22	15 45.87	69	1 26.86	8 23.2	2 26.9	11 57.16		
Sat. 21	23 26 34.6		+ 0.19	15 45.81	69	1 39.83	8 19.3	2 23.0	11 57.07		
Sun. 22	23 26 26.7		- 0.84	15 45.75	69	1 52.76	8 15.4	2 19.0	11 57.01		
Mon. 23	23 25 54.1		1.87	15 45.70	69	2 05.65	8 11.5	2 15.1	11 56.97		
Tues. 24	23 24 56.9		2.90	15 45.65	69	2 18.46	8 07.6	2 11.2	11 56.93		
Wed. 25	23 23 34.9		3.93	15 45.60	69	2 31.19	8 03.7	2 07.3	11 56.88		
Thur. 26	23 21 48.3		4.96	15 45.55	69	2 43.82	7 59.7	2 03.4	11 56.81		
Fri. 27	23 19 37.0		5.98	15 45.51	69	2 56.32	7 55.8	1 59.5	11 56.73		
Sat. 28	23 17 01.1		7.01	15 45.48	69	3 08.68	7 51.9	1 55.6	11 56.63		
Sun. 29	23 14 00.7		8.03	15 45.44	69	3 20.86	7 48.0	1 51.7	11 56.52		
Mon. 30	23 10 35.8		9.04	15 45.41	69	3 32.86	7 44.1	1 47.8	11 56.40		
Tues. 31	N23 06 46.6		-10.06	15 45.39	69	3 44.64	7 40.2 A.M.	E.E. 1 43.9 A.M.	11 56.30		

The sign + prefixed to the hourly change of declination indicates that { north } declinations are { increasing. }
south } decreasing.

The sign - prefixed to the hourly change of declination indicates that { south } declinations are { increasing. }
north } decreasing.

AT GREENWICH APPARENT NOON							POLARIS FOR THE MERIDIAN OF GREENWICH, CIVIL DATE AND MEAN TIME			
Date	THE SUN'S			Time Semi- diam- eter Pass- ing Mer.	Equation of Time, Add to Apparent Time	Upper Cul- mination	Elongation Lat. 40°	Decli- nation		
	Apparent Declination	Diff. for 1 Hour	Semi- diam- eter							
J U L Y , 1 9 8 6										
Tues. 1	N23 06 46.6	-10.06	15 45.39	69	3 44.64	7 40.2 A.M.	E.E. 1 43.9 A.M.	11 56.30		
Wed. 2	23 02 33.0	11.07	15 45.37	69	3 56.18	7 36.3	1 40.0	11 56.21		
Thur. 3	22 57 55.3	12.07	15 45.36	69	4 07.46	7 32.4	1 36.1	11 56.13		
Fri. 4	22 52 53.5	13.07	15 45.35	69	4 18.45	7 28.5	1 32.2	11 56.08		
Sat. 5	22 47 27.7	14.07	15 45.35	69	4 29.13	7 24.6	1 28.3	11 56.05		
Sun. 6	22 41 38.2	15.06	15 45.35	69	4 39.48	7 20.7	1 24.4	11 56.03		
Mon. 7	22 35 25.0	16.04	15 45.36	68	4 49.47	7 16.8	1 20.4	11 56.03		
Tues. 8	22 28 48.3	17.02	15 45.38	68	4 59.09	7 12.9	1 16.5	11 56.04		
Wed. 9	22 21 48.2	17.98	15 45.40	68	5 08.30	7 09.0	1 12.6	11 56.05		
Thur. 10	22 14 25.0	18.95	15 45.42	68	5 17.09	7 05.1	1 08.7	11 56.06		
Fri. 11	22 06 38.8	19.90	15 45.45	68	5 25.44	7 01.2	1 04.8	11 56.06		
Sat. 12	21 58 29.8	20.85	15 45.49	68	5 33.33	6 57.2	1 00.9	11 56.04		
Sun. 13	21 49 58.2	21.78	15 45.53	68	5 40.75	6 53.3	0 57.0	11 56.02		
Mon. 14	21 41 04.2	22.71	15 45.58	68	5 47.66	6 49.4	0 53.1	11 55.99		
Tues. 15	21 31 48.0	23.63	15 45.63	68	5 54.07	6 45.5	0 49.2	11 55.96		
Wed. 16	21 22 09.9	24.54	15 45.68	68	5 59.95	6 41.6	0 45.3	11 55.94		
Thur. 17	21 12 10.0	25.44	15 45.74	68	6 05.30	6 37.7	0 41.4	11 55.94		
Fri. 18	21 01 48.7	26.33	15 45.80	68	6 10.10	6 33.8	0 37.5	11 55.98		
Sat. 19	20 51 06.1	27.21	15 45.87	68	6 14.35	6 29.9	0 33.6	11 56.04		
Sun. 20	20 40 02.5	28.08	15 45.94	68	6 18.04	6 26.0	0 29.7	11 56.13		
Mon. 21	20 28 38.1	28.94	15 46.01	68	6 21.17	6 22.1	0 25.8	11 56.24		
Tues. 22	20 16 53.2	29.79	15 46.08	67	6 23.74	6 18.2	0 21.9	11 56.34		
Wed. 23	20 04 48.0	30.64	15 46.16	67	6 25.73	6 14.3	0 18.0	11 56.43		
Thur. 24	19 52 22.7	31.47	15 46.24	67	6 27.16	6 10.4	0 14.1	11 56.50		
Fri. 25	19 39 37.6	32.29	15 46.32	67	6 28.02	6 06.5	0 10.1	11 56.55		
Sat. 26	19 26 32.7	33.10	15 46.41	67	6 28.30	6 02.6	0 06.2	11 56.58		
Sun. 27	19 13 08.6	33.91	15 46.50	67	6 28.00	5 58.7	{ 0 02.3 A.M. 11 58.4 P.M. }	11 56.62		
Mon. 28	18 59 25.3	34.70	15 46.59	67	6 27.12	5 54.8	11 54.5	11 56.65		
Tues. 29	18 45 23.1	35.48	15 46.69	67	6 25.66	5 50.9	11 50.6	11 56.70		
Wed. 30	18 31 02.4	36.24	15 46.80	67	6 23.61	5 47.0	11 46.7	11 56.76		
Thur. 31	N18 16 23.3	-37.00	15 46.90	67	6 20.97	5 43.1 A.M.	E.E. 11 42.8 P.M.	11 56.84		
A U G U S T , 1 9 8 6										
Fri. 1	N18 01 26.3	-37.75	15 47.02	67	6 17.73	5 39.2 A.M.	E.E. 11 38.9 P.M.	11 56.95		
Sat. 2	17 46 11.6	38.48	15 47.13	66	6 13.91	5 35.3	11 35.0	11 57.07		
Sun. 3	17 30 39.4	39.20	15 47.25	66	6 09.48	5 31.4	11 31.1	11 57.21		
Mon. 4	17 14 50.2	39.90	15 47.38	66	6 04.46	5 27.4	11 27.2	11 57.36		
Tues. 5	16 58 44.1	40.60	15 47.51	66	5 58.84	5 23.5	11 23.3	11 57.51		
Wed. 6	16 42 21.5	41.28	15 47.65	66	5 52.61	5 19.6	11 19.4	11 57.67		
Thur. 7	16 25 42.8	41.94	15 47.79	66	5 45.79	5 15.7	11 15.5	11 57.81		
Fri. 8	16 08 48.2	42.60	15 47.94	66	5 38.37	5 11.8	11 11.5	11 57.94		
Sat. 9	15 51 38.1	43.24	15 48.09	66	5 30.36	5 07.9	11 07.6	11 58.06		
Sun. 10	15 34 12.7	43.87	15 48.25	66	5 21.75	5 04.0	11 03.7	11 58.17		
Mon. 11	15 16 32.5	44.48	15 48.41	66	5 12.55	5 00.1	10 59.8	11 58.28		
Tues. 12	14 58 37.7	45.08	15 48.57	66	5 02.77	4 56.2	10 55.9	11 58.40		
Wed. 13	14 40 28.6	45.67	15 48.74	66	4 52.41	4 52.3	10 52.0	11 58.53		
Thur. 14	14 22 05.7	46.24	15 48.92	65	4 41.48	4 48.4	10 48.1	11 58.69		
Fri. 15	14 03 29.1	46.80	15 49.09	65	4 29.99	4 44.5	10 44.2	11 58.88		
Sat. 16	N13 44 39.3	-47.35	15 49.27	65	4 17.95	4 40.6 A.M.	E.E. 10 40.3 P.M.	11 59.10		

The sign - prefixed to the hourly change of declination indicates that { south
north } declinations are { increasing.
decreasing.

The sign — prefixed to the hourly change of declination indicates that $\left\{ \begin{array}{l} \text{south} \\ \text{north} \end{array} \right\}$ declinations are $\left\{ \begin{array}{l} \text{increasing.} \\ \text{decreasing.} \end{array} \right.$

AT GREENWICH APPARENT NOON						POLARIS FOR THE MERIDIAN OF GREENWICH, CIVIL DATE AND MEAN TIME				
Date	THE SUN'S			Time Semi- diam- eter Pass- ing Mer.	Equation of Time, Subtract from Apparent Time	Upper Cul- mination	Elongation Lat. 40°	Decli- nation		
	Apparent Declination	Diff. for 1 Hour	Semi- diam- eter							
O C T O B E R , 1 9 8 6										
Wed. 1	S 3° 10' 35.1	-58.21	16 00.09	64	10 15.66	1 40.7 A.M.	E.E. 7 40.4 P.M.	+89° 12 11.62		
Thur. 2	3 33 51.1	58.12	16 00.36	64	10 34.81	1 36.8	7 36.5	12 11.96		
Fri. 3	3 57 04.7	58.01	16 00.64	64	10 53.63	1 32.9	7 32.6	12 12.29		
Sat. 4	4 20 15.6	57.89	16 00.91	64	11 12.13	1 28.9	7 28.7	12 12.60		
Sun. 5	4 43 23.4	57.75	16 01.19	64	11 30.29	1 25.0	7 24.7	12 12.91		
Mon. 6	5 06 27.6	57.60	16 01.47	65	11 48.08	1 21.1	7 20.8	12 13.23		
Tues. 7	5 29 27.9	57.43	16 01.75	65	12 05.49	1 17.2	7 16.9	12 13.57		
Wed. 8	5 52 24.0	57.24	16 02.03	65	12 22.51	1 13.3	7 13.0	12 13.93		
Thur. 9	6 15 15.4	57.03	16 02.32	65	12 39.13	1 09.4	7 09.1	12 14.32		
Fri. 10	6 38 01.7	56.82	16 02.60	65	12 55.31	1 05.4	7 05.2	12 14.73		
Sat. 11	7 00 42.5	56.58	16 02.88	65	13 11.05	1 01.5	7 01.2	12 15.14		
Sun. 12	7 23 17.5	56.33	16 03.16	65	13 26.33	0 57.6	6 57.3	12 15.56		
Mon. 13	7 45 46.3	56.06	16 03.44	65	13 41.11	0 53.7	6 53.4	12 15.96		
Tues. 14	8 08 08.6	55.78	16 03.72	65	13 55.39	0 49.8	6 49.5	12 16.34		
Wed. 15	8 30 23.9	55.49	16 04.00	65	14 09.15	0 45.8	6 45.5	12 16.70		
Thur. 16	8 52 32.0	55.18	16 04.28	65	14 22.35	0 41.9	6 41.6	12 17.04		
Fri. 17	9 14 32.5	54.86	16 04.55	65	14 34.98	0 38.0	6 37.7	12 17.37		
Sat. 18	9 36 25.1	54.52	16 04.82	65	14 47.02	0 34.1	6 33.8	12 17.70		
Sun. 19	9 58 09.4	54.16	16 05.10	66	14 58.44	0 30.1	6 29.8	12 18.03		
Mon. 20	10 19 45.0	53.80	16 05.36	66	15 09.24	0 26.2	6 25.9	12 18.38		
Tues. 21	10 41 11.6	53.41	16 05.63	66	15 19.38	0 22.3	6 22.0	12 18.74		
Wed. 22	11 02 28.8	53.01	16 05.89	66	15 28.86	0 18.4	6 18.1	12 19.12		
Thur. 23	11 23 36.2	52.60	16 06.16	66	15 37.65	0 14.5	6 14.2	12 19.51		
Fri. 24	11 44 33.4	52.17	16 06.42	66	15 45.74	0 10.5	6 10.2	12 19.91		
Sat. 25	12 05 20.1	51.72	16 06.67	66	15 53.11	0 06.6	6 06.3	12 20.33		
Sun. 26	12 25 55.8	51.25	16 06.93	66	15 59.75	{ 0 02.7 A.M. 11 58.7 P.M. }	E.E. 6 02.4 P.M.	{ 12 20.74 12 21.15 }		
Mon. 27	12 46 20.2	50.77	16 07.19	66	16 05.64	11 54.8	W.E. 5 55.1 A.M.	2 2.55		
Tues. 28	13 06 32.7	50.27	16 07.44	66	16 10.78	11 50.9	5 51.2	12 21.93		
Wed. 29	13 26 33.1	49.75	16 07.70	67	16 15.14	11 46.9	5 47.2	12 22.30		
Thur. 30	13 46 20.8	49.22	16 07.95	67	16 18.72	11 43.0	5 43.3	12 22.65		
Fri. 31	S14 05 55.5	-48.67	16 08.20	67	16 21.50	11 39.1 P.M.	W.E. 5 39.4 A.M.	12 22.99		
N O V E M B E R , 1 9 8 6										
Sat. 1	S14 25 16.8	-48.10	16 08.45	67	16 23.49	11 35.2 P.M.	W.E. 5 35.4 A.M.	12 23.33		
Sun. 2	14 44 24.1	47.51	16 08.70	67	16 24.68	11 31.2	5 31.5	12 23.68		
Mon. 3	15 03 17.1	46.90	16 08.95	67	16 25.06	11 27.3	5 27.6	12 24.06		
Tues. 4	15 21 55.4	46.28	16 09.20	67	16 24.63	11 23.4	5 23.7	12 24.46		
Wed. 5	15 40 18.5	45.64	16 09.45	67	16 23.39	11 19.5	5 19.7	12 24.89		
Thur. 6	15 58 25.9	44.98	16 09.70	67	16 21.33	11 15.5	5 15.8	12 25.32		
Fri. 7	16 16 17.3	44.30	16 09.94	68	16 18.46	11 11.6	5 11.9	12 25.76		
Sat. 8	16 33 52.2	43.60	16 10.19	68	16 14.78	11 07.7	5 08.0	12 26.18		
Sun. 9	16 51 10.3	42.89	16 10.43	68	16 10.26	11 03.7	5 04.0	12 26.57		
Mon. 10	17 08 11.1	42.16	16 10.67	68	16 04.93	10 59.8	5 00.1	12 26.95		
Tues. 11	17 24 54.2	41.42	16 10.90	68	15 58.76	10 55.9	4 56.2	12 27.30		
Wed. 12	17 41 19.2	40.66	16 11.13	68	15 51.75	10 51.9	4 52.2	12 27.64		
Thur. 13	17 57 25.9	39.89	16 11.36	68	15 43.91	10 48.0	4 48.3	12 27.97		
Fri. 14	18 13 13.7	39.10	16 11.59	68	15 35.24	10 44.0	4 44.3	12 28.30		
Sat. 15	18 28 42.5	38.29	16 11.81	68	15 25.72	10 40.1	4 40.4	12 28.63		
Sun. 16	S18 43 51.7	-37.47	16 12.02	69	15 15.36	10 36.2 P.M.	W.E. 4 36.5 A.M.	12 28.98		

The sign - prefixed to the hourly change of declination indicates that { south } declinations are { increasing.
north } decreasing.

For time of Eastern Elongation of Polaris for any date after October 26th, subtract 5^h 56.4^m from the time of Upper Culmination of the same date.

AT GREENWICH APPARENT NOON							POLARIS FOR THE MERIDIAN OF GREENWICH, CIVIL DATE AND MEAN TIME				
Date	THE SUN'S			Time Semi- diam- eter Pass- ing Mer.	Equation of Time, Subtract from Add to Apparent Time	Upper Cul- mination	Elongation Lat. 40°	Decli- nation			
	Apparent Declination	Diff. for 1 Hour	Semi- diam- eter								
NOVEMBER, 1986											
Sun. 16	S18 43 51.7	-37.47	16 12.02	69	15 15.36	10 36.2 P.M.	W.E. 4 36.5 A.M.	+89° 12 28.98			
Mon. 17	18 58 41.0	36.63	16 12.23	69	15 04.16	10 32.2	4 32.5	12 29.34			
Tues. 18	19 13 10.1	35.78	16 12.44	69	14 52.12	10 28.3	4 28.6	12 29.72			
Wed. 19	19 27 18.7	34.92	16 12.64	69	14 39.25	10 24.4	4 24.7	12 30.10			
Thur. 20	19 41 06.2	34.04	16 12.84	69	14 25.55	10 20.4	4 20.7	12 30.49			
Fri. 21	19 54 32.4	33.14	16 13.03	69	14 11.02	10 16.5	4 16.8	12 30.89			
Sat. 22	20 07 37.0	32.23	16 13.22	69	13 55.68	10 12.6	4 12.9	12 31.28			
Sun. 23	20 20 19.5	31.30	16 13.41	69	13 39.52	10 08.6	4 08.9	12 31.66			
Mon. 24	20 32 39.6	30.36	16 13.59	70	13 22.57	10 04.7	4 05.0	12 32.02			
Tues. 25	20 44 36.9	29.41	16 13.77	70	13 04.83	10 00.7	4 01.1	12 32.36			
Wed. 26	20 56 11.1	28.44	16 13.94	70	12 46.31	9 56.8	3 57.1	12 32.69			
Thur. 27	21 07 21.8	27.45	16 14.11	70	12 27.03	9 52.9	3 53.2	12 33.00			
Fri. 28	21 18 08.7	26.45	16 14.28	70	12 07.01	9 48.9	3 49.2	12 33.30			
Sat. 29	21 28 31.5	25.44	16 14.44	70	11 46.26	9 45.0	3 45.3	12 33.60			
Sun. 30	S21 38 29.9	-24.42	16 14.61	70	11 24.81	9 41.0 P.M.	W.E. 3 41.3 A.M.	12 33.93			
DECEMBER, 1986											
Mon. 1	S21 48 03.5	-23.38	16 14.76	70	11 02.69	9 37.1 P.M.	W.E. 3 37.4 A.M.	12 34.27			
Tues. 2	21 57 12.0	22.33	16 14.92	70	10 39.91	9 33.2	3 33.5	12 34.64			
Wed. 3	22 05 55.2	21.27	16 15.08	70	10 16.52	9 29.2	3 29.5	12 35.03			
Thur. 4	22 14 12.7	20.19	16 15.23	70	9 52.53	9 25.3	3 25.6	12 35.42			
Fri. 5	22 22 04.4	19.11	16 15.38	71	9 27.98	9 21.3	3 21.7	12 35.79			
Sat. 6	22 29 29.8	18.01	16 15.52	71	9 02.90	9 17.4	3 17.7	12 36.14			
Sun. 7	22 36 28.9	16.91	16 15.66	71	8 37.31	9 13.4	3 13.8	12 36.47			
Mon. 8	22 43 01.3	15.79	16 15.80	71	8 11.24	9 09.5	3 09.8	12 36.76			
Tues. 9	22 49 06.9	14.67	16 15.93	71	7 44.71	9 05.5	3 05.9	12 37.04			
Wed. 10	22 54 45.5	13.54	16 16.06	71	7 17.76	9 01.6	3 01.9	12 37.30			
Thur. 11	22 59 56.9	12.41	16 16.18	71	6 50.41	8 57.6	2 58.0	12 37.56			
Fri. 12	23 04 41.0	11.26	16 16.30	71	6 22.69	8 53.7	2 54.0	12 37.81			
Sat. 13	23 08 57.6	10.12	16 16.41	71	5 54.63	8 49.8	2 50.1	12 38.08			
Sun. 14	23 12 46.7	8.97	16 16.52	71	5 26.26	8 45.8	2 46.1	12 38.36			
Mon. 15	23 16 08.0	7.81	16 16.62	71	4 57.59	8 41.9	2 42.2	12 38.65			
Tues. 16	23 19 01.5	6.65	16 16.71	71	4 28.68	8 37.9	2 38.2	12 38.95			
Wed. 17	23 21 27.0	5.48	16 16.80	71	3 59.53	8 34.0	2 34.3	12 39.25			
Thur. 18	23 23 24.6	4.31	16 16.88	71	3 30.19	8 30.0	2 30.4	12 39.55			
Fri. 19	23 24 54.1	3.14	16 16.96	71	3 00.68	8 26.1	2 26.4	12 39.85			
Sat. 20	23 25 55.5	1.97	16 17.03	71	2 31.03	8 22.1	2 22.5	12 40.14			
Sun. 21	23 26 28.7	- 0.79	16 17.09	71	2 01.28	8 18.2	2 18.5	12 40.41			
Mon. 22	23 26 33.6	+ 0.38	16 17.15	71	1 31.45	8 14.2	2 14.5	12 40.66			
Tues. 23	23 26 10.2	1.56	16 17.20	71	1 01.59	8 10.3	2 10.6	12 40.89			
Wed. 24	23 25 18.6	2.74	16 17.25	71	0 31.71	8 06.3	2 06.6	12 41.10			
Thur. 25	23 23 58.7	3.92	16 17.29	71	0 01.85	8 02.4	2 02.7	12 41.29			
Fri. 26	23 22 10.5	5.10	16 17.33	71	0 27.94	7 58.4	1 58.7	12 41.48			
Sat. 27	23 19 54.1	6.27	16 17.37	71	0 57.65	7 54.5	1 54.8	12 41.68			
Sun. 28	23 17 09.5	7.44	16 17.40	71	1 27.23	7 50.5	1 50.8	12 41.90			
Mon. 29	23 13 56.9	8.61	16 17.42	71	1 56.64	7 46.6	1 46.9	12 42.14			
Tues. 30	23 10 16.2	9.78	16 17.44	71	2 25.85	7 42.6	1 42.9	12 42.40			
Wed. 31	23 06 07.6	10.93	16 17.46	71	2 54.82	7 38.7	1 39.0	12 42.66			
Thur. 32	S23 01 31.3	+12.09	16 17.48	71	3 23.50	7 34.7 P.M.	W.E. 1 35.0 A.M.	12 42.93			

The sign + prefixed to the hourly change of declination indicates that { north } declinations are { increasing. }
south } decreasing.

The sign - prefixed to the hourly change of declination indicates that { south } declinations are { increasing. }
north } decreasing.

SELECTED STARS

Serial Number this list	No. from Nautical Almanac	Constellation Name	North Declination			South Declination		
			R.A.	Decl.	Mag.	R.A.	Decl.	Mag.
			h m	°		h m	°	
1	1	α Andromedae (Alpheratz)	0 08	+29	2.2			
2 x X		β Hydri				0 25	-77	2.9
3	4	β Ceti (Diphda)				0 43	-18	2.2
4 E		α Ursae Minoris (Polaris)	2 15	+89	2.1			
5	6	α Arietis (Hamal)	2 06	+23	2.2			
6	10	α Tauri (Aldebaran)	4 35	+16	1.1			
7	11	β Orionis (Rigel)				5 14	- 8	0.3
8	12	α Aurigae (Capella)	5 16	+46	0.2			
9	16	α Orionis (Betelgeuse)	5 54	+ 7	0.5 v			
10 x	17	α Carinae (Canopus)				6 24	-53	-0.9
11	18	α Canis Majoris (Sirius)				6 45	-17	-1.6
12	20	α Canis Minoris (Procyon)	7 39	+ 5	0.5			
13	21	β Geminorum (Pollux)	7 44	+28	1.2			
14	25	α Hydrae (Alphard)				9 27	- 9	2.2
15	26	α Leonis (Regulus)	10 08	+12	1.3			
16	28	β Leonis (Denebola)	11 48	+15	2.2			
17	33	α Virginis (Spica)				13 24	-11	1.2
18 x	36	θ Centauri (Menkent)				14 06	-36	2.3
19	37	α Bootis (Arcturus)	14 15	+19	0.2			
20	41	α Coronae Borealis (Alphecca)	15 34	+27	2.3			
21 x	42	α Scorpii (Antares)				16 29	-26	1.2
22	46	α Ophiuchi (Rasalhague)	17 34	+13	2.1			
23	49	α Lyrae (Vega)	18 36	+39	0.1			
24 x	50	σ Sagittarii (Nunki)				18 54	-26	2.1
25	51	α Aquilae (Altair)	19 50	+ 9	0.9			
26	54	ϵ Pegasi (Enif)	21 43	+10	2.5			
27 x	56	α Piscis Australis (Fomalhaut)				22 57	-30	1.3
28	57	α Pegasi (Markab)	23 04	+15	2.6			

- x: Required for stations south of 30° north latitude.
X: South circumpolar; not included in principal list of stars, Nautical Almanac.
E: Tabulated in this Ephemeris for daily position, including elongation.
v: Varies from 0.1 to 1.2 in magnitude or brilliancy.
 α : Alpha. β : Beta. ϵ : Epsilon. θ : Theta. σ : Sigma. These designations are in the order of brightness, each within its own constellation.

The planets and the bright stars Capella, Canopus, and Vega, are tabulated as an aid in finding stellar positions.

For the south circumpolar star, No. 2 β Hydri, the horizontal angles, and the hour angle at elongation, may be found by the following equations (the lat. and decl. being treated as positive):

At elongation: $\cos t = \cot \delta \tan \phi$; and, $\sin A = \frac{\cos \delta}{\cos \phi}$

At any hour angle: $\tan A = \frac{\sin t}{\cos \phi \tan \delta - \sin \phi \cos t}$

The product, $\sin \phi \cos t$, is subtracted for hour angles 0° to 90°; added for hour angles 90° to 180°. The hour angle, t, in these equations is in sidereal rate; conversions page 27.

STAR TABLES, MERIDIAN OF GREENWICH, CIVIL DATE AND MEAN TIME

No.	Mag.									Transit	
		Transit	Decl.	Transit	Decl.	Transit	Decl.	Transit	Decl.	Subtract for day of month	
		Jan. 1		Jan. 16		Feb. 1		Feb. 16			
		^h ^m	[°] [']	^h ^m	[']	^h ^m	[']	^h ^m	[']		^m
1- 1	2.2	5 23.4 PM	+29 00.9	4 24.4 PM	00.9	3 21.5 PM	00.8	2 22.5 PM	00.8	1	0.0
2	2.9	5 40.7	-77 20.4	4 41.7	20.3	3 38.8	20.3	2 39.8	20.2	2	3.9
3- 4	2.2	5 58.5	-18 04.0	4 59.5	04.0	3 56.6	04.0	2 57.6	04.0	3	7.9
4	2.1	7 32.8	+89 12.4	6 33.5	12.4	5 30.1	12.4	4 30.8	12.4	4	11.8
5- 6	2.2	7 21.8	+23 23.9	6 22.8	23.9	5 19.9	23.9	4 20.9	23.9	5	15.7
6-10	1.1	9 50.1	+16 29.0	8 51.1	29.0	7 48.2	29.0	6 49.3	29.0	6	19.7
7-11	0.3	10 28.8	- 8 13.0	9 29.8	13.0	8 26.9	13.0	7 27.9	13.1	7	23.6
8-12	0.2	10 30.6	+45 59.3	9 31.6	59.3	8 28.7	59.3	7 29.7	59.4	8	27.5
9-16	0.5 _v	11 09.2	+ 7 24.4	10 10.2	24.4	9 07.3	24.4	8 08.3	24.4	9	31.5
10-17	-0.9	11 38.4 PM	-52 41.2	10 39.4	41.3	9 36.5	41.3	8 37.5	41.4	10	35.4
11-18	-1.6	{ 0 03.1 AM 11 59.2 PM }	-16 41.7	11 00.2	41.7	9 57.3	41.8	8 58.3	41.8	11	39.3
12-20	0.5	{ 0 57.0 AM 0 02.0 AM }	+ 5 15.8	11 54.1 PM	15.8	10 51.2	15.7	9 52.2	15.7	12	43.2
Jan. 15		{ 11 58.0 PM }								13	47.2
13-21	1.2	1 02.9 AM	+28 03.7	{ 0 03.9 AM 11 60.0 PM }	03.7	10 57.1 PM	03.7	9 58.1	03.7	14	51.1
14-25	2.2	2 45.1	- 8 35.7	1 46.1 AM	35.8	{ 0 43.2 AM 0 03.8 AM 11 59.9 PM }	35.8	11 40.3 PM	35.9	15	55.0
Feb. 11										16	0.0
15-26	1.3	3 25.7	+12 02.2	2 26.7	02.2	1 23.8 AM	02.1	{ 0 24.8 AM 0 01.2 AM 11 57.3 PM }	02.1	17	3.9
Feb. 22										18	7.9
16-28	2.2	5 06.1	+14 39.0	4 07.1	38.9	3 04.2	38.9	2 05.3 AM	38.9	19	11.8
17-33	1.2	6 41.9 ²	-11 05.3	5 43.0	05.3	4 40.1	05.4	3 41.1	05.4	20	15.7
18-36	2.3	7 23.2	-36 17.9	6 24.2	18.0	5 21.3	18.0	4 22.4	18.1	21	19.7
19-37	0.2	7 32.4	+19 15.2	6 33.4	15.1	5 30.5	15.0	4 31.5	15.0	22	23.6
20-41	2.3	8 51.2	+26 45.5	7 52.2	45.4	6 49.3	45.4	5 50.4	45.3	23	27.5
21-42	1.2	9 45.5 ⁴	-26 24.1	8 46.5 ⁴	24.1	7 43.6 ² ⁴	24.2	6 44.7 ² ⁴	24.2	24	31.5
22-46	2.1	10 51.1	+12 34.0	9 52.1	34.0	8 49.2	33.9	7 50.2	33.9	25	35.4
23-49	0.1	11 53.1 AM	+38 46.1	10 54.1	46.0	9 51.2	45.9	8 52.2	45.8	26	39.3
24-50	2.1	12 11.0 PM ¹	-26 19.1	11 12.0 AM ¹	19.1	10 09.1	19.0	9 10.1	19.0	27	43.2
25-51	0.9	1 06.5	+ 8 49.7	12 07.5 PM	49.7	11 04.6 AM	49.6	10 05.7	49.6	28	47.2
26-54	2.5	2 59.6	+ 9 48.5	2 00.6	48.5	12 57.7 PM	48.5	11 58.7 AM	48.4	29	51.1
27-56	1.3	4 12.8	-29 42.1	3 13.8	42.1	2 10.9	42.0	1 11.9 PM	42.0	30	55.0
28-57	2.6	4 19.9 PM	+15 07.8	3 21.0 PM	07.7	2 18.1 PM	07.7	1 19.1 PM	07.7	31	59.0
¹ Venus	-3.5	11 45 AM	-24	12 07 PM	-22	12 27 PM	-17	12 42 PM	-11		
² Mars	1.3	7 52 AM	-14	7 29 AM	-17	7 05 AM	-19	6 42 AM	-21		
³ Jupiter	-1.5	2 40 PM	-16	1 55 PM	-15	1 06 PM	-14	12 21 PM	-13		
⁴ Saturn	0.7	9 31 AM	-19	8 39 AM	-20	7 41 AM	-20	6 46 AM	-20		

Footnotes indicate near proximity of a planet to a star in time of transit and declination.

For time of transit subsequent to a star's double transit and until the next tabulated date, subtract for the number of days counting from the second transit of that date. All other interpolations may be taken directly by reference to the day of the month.

STAR TABLES, MERIDIAN OF GREENWICH, CIVIL DATE AND MEAN TIME

No.	Mag.									Transit	
		Transit	Decl.	Transit	Decl.	Transit	Decl.	Transit	Decl.	Subtract	
		Mar. 1		Mar. 16		Apr. 1		Apr. 16		for day of month	
		^h ^m	[°] [']	^h ^m	[']	^h ^m	[']	^h ^m	[']		^m
1- 1	2.2	1 31.4 PM	+29 00.7	12 32.4 PM	00.7	11 29.5 AM	00.7	10 30.5 AM	00.7	1	0.0
2	2.9	1 48.7	-77 20.1	12 49.7	20.1	11 46.8 AM	19.9	10 47.8	19.8	2	3.9
3- 4	2.2	2 06.5	-18 04.0	1 07.6	03.9	12 04.6 PM	03.9	11 05.7 AM	03.8	3	7.9
4	2.1	3 39.4	+89 12.4	2 40.1	12.3	1 37.0	12.3	12 37.9 PM	12.2	4	11.8
5- 6	2.2	3 29.8	+23 23.9	2 30.8	23.8	1 27.9	23.8	12 28.9 ¹	23.8	5	15.7
6-10	1.1	5 58.1	+16 29.0	4 59.2	29.0	3 56.2	29.0	2 57.3	29.0	6	19.7
7-11	0.3	6 36.8	- 8 13.1	5 37.8	13.1	4 34.9	13.1	3 35.9	13.0	7	23.6
8-12	0.2	6 38.6	+45 59.4	5 39.6	59.4	4 36.7	59.3	3 37.7	59.3	8	27.5
9-16	0.5 _v	7 17.2	+ 7 24.4	6 18.2	24.4	5 15.3	24.4	4 16.4	24.4	9	31.5
10-17	-0.9	7 46.4	-52 41.4	6 47.4	41.5	5 44.5	41.5	4 45.5	41.4	10	35.4
11-18	-1.6	8 07.2	-16 41.8	7 08.2	41.9	6 05.3	41.9	5 06.3	41.9	11	39.3
12-20	0.5	9 01.1	+ 5 15.7	8 02.1	15.7	6 59.2	15.7	6 00.2	15.7	12	43.2
13-21	1.2	9 07.0	+28 03.8	8 08.0	03.8	7 05.1	03.8	6 06.1	03.8	13	47.2
14-25	2.2	10 49.1	- 8 35.9	9 50.2	35.9	8 47.3	36.0	7 48.3	36.0	14	51.1
15-26	1.3	11 29.8 PM	+12 02.1	10 30.8 PM	02.1	9 27.9	02.1	8 28.9	02.1	15	55.0
16-28	2.2	1 14.1 AM	+14 38.9	0 15.2 AM { 0 03.4 AM 11 59.4 PM }	38.9	11 08.3 PM	38.9	10 09.3	38.9	16	0.0
Mar. 19										17	3.9
17-33	1.2	2 50.0	-11 05.4	1 51.0 AM	05.5	0 48.1 AM { 0 00.9 AM 11 57.0 PM }	05.5	11 45.2 PM	05.5	18	7.9
Apr. 13										19	11.8
18-36	2.3	3 31.3	-36 18.1	2 32.3	18.2	1 29.4 AM	18.2	0 30.4 AM { 0 02.9 AM 11 59.0 PM }	18.3	20	15.7
Apr. 23										21	19.7
19-37	0.2	3 40.4	+19 15.0	2 41.4	15.0	1 38.5	15.0	0 39.6 AM { 0 00.2 AM 11 56.3 PM }	15.1	22	23.6
Apr. 26										23	27.5
20-41	2.3	4 59.3	+26 45.3	4 00.3	45.3	2 57.4	45.3	1 58.4 AM	45.4	24	31.5
21-42	1.2	5 53.6 ² ₄	-26 24.2	4 54.6 ² ₄	24.2	3 51.7 ⁴	24.2	2 52.7 ⁴	24.3	25	35.4
22-46	2.1	6 59.1	+12 33.8	6 00.1	33.8	4 57.2	33.8	3 58.3	33.9	26	39.3
23-49	0.1	8 01.1	+38 45.8	7 02.1	45.8	5 59.2	45.8	5 00.3	45.8	27	43.2
24-50	2.1	8 19.0	-26 19.0	7 20.0	19.0	6 17.1 ²	19.0	5 18.2 ²	19.0	28	47.2
25-51	0.9	9 14.5	+ 8 49.6	8 15.6	49.6	7 12.7	49.6	6 13.7	49.6	29	51.1
26-54	2.5	11 07.6 AM	+ 9 48.4	10 08.7	48.4	9 05.8	48.4	8 06.8	48.4	30	55.0
27-56	1.3	12 20.8 PM	-29 42.0	11 21.8	41.9	10 18.9	41.9	9 20.0	41.8	31	59.0
28-57	2.6	12 28.0 PM	+15 07.6	11 29.0 AM	07.6	10 26.1 AM	07.6	9 27.1 AM	07.6		
¹ Venus	-3.3	12 51 PM	- 5	1 00 PM	+ 3	1 10 PM	+11	1 22 PM	+17		
² Mars	0.3	6 23 AM	-22	5 59 AM	-23	5 32 AM	-24	5 03 AM	-24		
³ Jupiter	-1.6	11 42 AM	-12	10 56 AM	-10	10 07 AM	- 9	9 20 AM	- 8		
⁴ Saturn	0.5	5 57 AM	-20	4 59 AM	-20	3 56 AM	-20	2 55 AM	-20		

Footnotes indicate near proximity of a planet to a star in time of transit and declination.

For reduction of time of transit from the Greenwich mean time to the local mean time at the longitude of the station, see table of Sidereal Conversions, page 27.

STAR TABLES, MERIDIAN OF GREENWICH, CIVIL DATE AND MEAN TIME

No.	Mag.									Transit	
		Transit	Decl.	Transit	Decl.	Transit	Decl.	Transit	Decl.	Subtract for day of month	
		May 1		May 16		June 1		June 16			
		^h ^m	[°] [']	^h ^m	[']	^h ^m	[']	^h ^m	[']		^m
1- 1	2.2	9 31.6 AM	+29 00.7	8 32.6 AM	00.7	7 29.7 AM	00.7	6 30.7 AM	00.7	1	0.0
2	2.9	9 48.9	-77 19.8	8 49.9	19.7	7 47.0	19.6	6 48.1	19.5	2	3.9
3- 4	2.2	10 06.7	-18 03.8	9 07.7	03.7	8 04.8	03.6	7 05.9	03.6	3	7.9
4	2.1	11 39.0	+89 12.1	10 40.2	12.1	9 37.5	12.0	8 38.8	12.0	4	11.8
5- 6	2.2	11 30.0 AM	+23 23.8	10 31.0 AM	23.8	9 28.1	23.8	8 29.1	23.8	5	15.7
6-10	1.1	1 58.3 PM ¹	+16 29.0	12 59.3 PM ¹	29.0	11 56.4 AM	29.0	10 57.4	29.0	6	19.7
7-11	0.3	2 36.9	- 8 13.0	1 38.0	13.0	12 35.0 PM	12.9	11 36.1	12.9	7	23.6
8-12	0.2	2 38.7	+45 59.3	1 39.7	59.3	12 36.8	59.2	11 37.9 AM	59.2	8	27.5
9-16	0.5 _v	3 17.4	+ 7 24.4	2 18.4	24.4	1 15.5	24.4	12 16.5 PM	24.4	9	31.5
10-17	-0.9	3 46.5	-52 41.4	2 47.5	41.4	1 44.6	41.3	12 45.6	41.2	10	35.4
11-18	-1.6	4 07.4	-16 41.8	3 08.4	41.8	2 05.5	41.8	1 06.5	41.7	11	39.3
12-20	0.5	5 01.3	+ 5 15.7	4 02.3	15.7	2 59.4	15.7	2 00.4	15.8	12	43.2
13-21	1.2	5 07.1	+28 03.8	4 08.2	03.8	3 05.2 ¹	03.8	2 06.3 ¹	03.8	13	47.2
14-25	2.2	6 49.3	- 8 36.0	5 50.3	35.9	4 47.4	35.9	3 48.4	35.9	14	51.1
15-26	1.3	7 29.9	+12 02.1	6 30.9	02.2	5 28.0	02.2	4 29.0	02.2	15	55.0
16-28	2.2	9 10.4	+14 38.9	8 11.4	39.0	7 08.5	39.0	6 09.5	39.0	16	0.0
17-33	1.2	10 46.2	-11 05.5	9 47.2	05.5	8 44.3	05.5	7 45.4	05.5	17	3.9
18-36	2.3	11 27.5	-36 18.3	10 28.5	18.4	9 25.6	18.4	8 26.6	18.4	18	7.9
19-37	0.2	11 36.7 PM	+19 15.1	10 37.7 PM	15.1	9 34.8	15.2	8 35.8	15.2	19	11.8
20-41	2.3	0 59.5 AM	+26 45.4	{ 0 00.5 AM 11 56.5 PM } ₄	45.5	10 53.6	45.5	9 54.6	45.6	20	15.7
21-42	1.2	1 53.8 ⁴	-26 24.3		24.3	11 47.9 PM ⁴	24.3	10 49.0 ⁴	24.3	21	19.7
May 29										22	23.6
22-46	2.1	2 59.3	+12 33.9	2 00.3 AM	33.9	{ 0 57.4 AM 0 02.4 AM 11 58.4 PM }	34.0	11 54.5 PM	34.0	23	27.5
June 15										24	31.5
23-49	0.1	4 01.3	+38 45.8	3 02.3	45.9	1 59.4 AM	46.0	1 00.5 AM	46.0	25	35.4
24-50	2.1	4 19.2 ²	-26 19.0	3 20.2 ²	19.0	2 17.3 ²	19.0	1 18.4 ²	19.0	26	39.3
25-51	0.9	5 14.7	+ 8 49.6	4 15.8	49.6	3 12.9	49.7	2 13.9	49.7	27	43.2
26-54	2.5	7 07.8	+ 9 48.4	6 08.8	48.5	5 05.9	48.5	4 07.0	48.6	28	47.2
27-56	1.3	8 21.0	-29 41.7	7 22.0	41.7	6 19.1	41.6	5 20.2	41.6	29	51.1
28-57	2.6	8 28.1 AM	+15 07.6	7 29.2 AM	07.7	6 26.3 AM	07.7	5 27.3 AM	07.8	30	55.0
¹ Venus	-3.4	1 38 PM	+22	1 58 PM	+25	2 19 PM	+25	2 36 PM	+22		
² Mars	-1.3	4 31 AM	-24	3 53 AM	-24	3 03 AM	-24	2 05 AM	-25		
³ Jupiter	-1.9	8 32 AM	- 7	7 42 AM	- 6	6 48 AM	- 5	5 55 AM	- 4		
⁴ Saturn	0.3	1 53 AM	-20	0 50 AM	-20	11 38 PM	-19	10 34 PM	-19		

Footnotes indicate near proximity of a planet to a star in time of transit and declination.

For time of transit subsequent to a star's double transit and until the next tabulated date, subtract for the number of days counting from the second transit of that date. All other interpolations may be taken directly by reference to the day of the month.

STAR TABLES, MERIDIAN OF GREENWICH, CIVIL DATE AND MEAN TIME

No.	Mag.									Transit	
		Transit	Decl.	Transit	Decl.	Transit	Decl.	Transit	Decl.	Subtract for day of month	
		July 1		July 16		Aug. 1		Aug. 16			
		^h ^m	[°] [']	^h ^m	[']	^h ^m	[']	^h ^m	[']		^m
1- 1	2.2	5 31.8 AM	+29 00.8	4 32.8 AM	00.8	3 29.9 AM	00.9	2 30.9 AM	01.0	1	0.0
2	2.9	5 49.1	-77 19.5	4 50.2	19.5	3 47.3	19.5	2 48.3	19.5	2	3.9
3- 4	2.2	6 06.9	-18 03.5	5 07.9	03.5	4 05.0	03.5	3 06.0	03.4	3	7.9
4	2.1	7 40.2	+89 11.9	6 41.6	11.9	5 39.1	11.9	4 40.6	12.0	4	11.8
5- 6	2.2	7 30.1	+23 23.9	6 31.2	23.9	5 28.3	23.9	4 29.3	24.0	5	15.7
6-10	1.1	9 58.5	+16 29.0	8 59.5	29.1	7 56.6	29.1	6 57.6	29.1	6	19.7
7-11	0.3	10 37.1	- 8 12.8	9 38.1	12.8	8 35.2	12.7	7 36.3	12.7	7	23.6
8-12	0.2	10 38.9	+45 59.2	9 39.9	59.2	8 37.0	59.1	7 38.0	59.1	8	27.5
9-16	0.5 _v	11 17.5	+ 7 24.5	10 18.6	24.5	9 15.7	24.5	8 16.7	24.5	9	31.5
10-17	-0.9	11 46.7 AM	-52 41.1	10 47.7	41.0	9 44.8	41.0	8 45.8	40.9	10	35.4
11-18	-1.6	12 07.5 PM	-16 41.7	11 08.5 AM	41.6	10 05.6	41.6	9 06.7	41.5	11	39.3
12-20	0.5	1 01.4	+ 5 15.8	12 02.4 PM	15.8	10 59.5	15.8	10 00.6	15.8	12	43.2
13-21	1.2	1 07.3	+28 03.8	12 08.3	03.8	11 05.4 AM	03.7	10 06.4	03.7	13	47.2
14-25	2.2	2 49.4	- 8 35.9	1 50.5	35.8	12 47.6 PM	35.8	11 48.6 AM	35.8	14	51.1
15-26	1.3	3 30.1 ¹	+12 02.2	2 31.1 ¹	02.2	1 28.2	02.2	12 29.2 PM	02.2	15	55.0
16-28	2.2	5 10.5	+14 39.0	4 11.5	39.0	3 08.6 ¹	39.0	2 09.7	39.0	16	0.0
17-33	1.2	6 46.4	-11 05.5	5 47.4	05.5	4 44.5	05.5	3 45.5 ¹	05.5	17	3.9
18-36	2.3	7 27.7	-36 18.4	6 28.7	18.4	5 25.8	18.4	4 26.8	18.4	18	7.9
19-37	0.2	7 36.8	+19 15.2	6 37.8	15.2	5 34.9	15.3	4 35.9	15.3	19	11.8
20-41	2.3	8 55.7	+26 45.6	7 56.7	45.7	6 53.8	45.7	5 54.8	45.7	20	15.7
21-42	1.2	9 50.0 ⁴	-26 24.3	8 51.0 ⁴	24.3	7 48.1 ⁴	24.3	6 49.1 ⁴	24.3	21	19.7
22-46	2.1	10 55.5 PM	+12 34.1	9 56.6	34.1	8 53.6	34.1	7 54.7	34.2	22	23.6
23-49	0.1	{ 0 01.5 AM 11 57.5 PM } ₂	+38 46.1	10 58.6	46.2	9 55.7	46.3	8 56.7	46.3	23	27.5
24-50	2.1	{ 0 19.4 AM 0 03.6 AM 11 59.7 PM }	-26 19.0	11 16.5 PM ²	19.0	10 13.6 ²	19.0	9 14.6 ²	19.0	24	31.5
July 5										25	35.4
25-51	0.9	1 14.9 AM	+ 8 49.8	0 15.9 AM { 0 00.2 AM 11 56.3 PM }	49.8	11 09.1 PM	49.9	10 10.1 PM	49.9	26	39.3
July 20										27	43.2
26-54	2.5	3 08.0	+ 9 48.6	2 09.0 AM	48.7	1 06.1 AM	48.7	0 07.2 AM { 0 03.2 AM 11 59.3 PM }	48.8	28	47.2
Aug. 17										29	51.1
27-56	1.3	4 21.2	-29 41.6	3 22.2	41.5	2 19.3	41.5	1 20.3 AM	41.5	30	55.0
28-57	2.6	4 28.3 AM	+15 07.8	3 29.4 AM	07.9	2 26.5 AM	07.9	1 27.5 AM	08.0	31	59.0
¹ Venus	-3.8	2 48 PM	+17 [°]	2 55 PM	+11 [°]	2 56 PM	+ 3 [°]	2 53 PM	- 5 [°]		
² Mars	-1.9	0 56 AM	-27	11 33 PM	-28	10 14 PM	-29	9 13 PM	-28		
³ Jupiter	-2.3	4 59 AM	- 4	4 01 AM	- 4	2 56 AM	- 4	1 53 AM	- 5		
⁴ Saturn	0.6	9 31 PM	-19	8 30 PM	-19	7 25 PM	-19	6 26 PM	-19		

Footnotes indicate near proximity of a planet to a star in time of transit and declination.

For reduction of time of transit from the Greenwich mean time to the local mean time at the longitude of the station, see table of Sidereal Conversions, page 27.

STAR TABLES, MERIDIAN OF GREENWICH, CIVIL DATE AND MEAN TIME

No.	Mag.									Transit	
		Transit	Decl.	Transit	Decl.	Transit	Decl.	Transit	Decl.	Subtract	
		Sept. 1		Sept. 16		Oct. 1		Oct. 16		for day of month	
		h m	° '	h m	° '	h m	° '	h m	° '	h m	° '
1- 1	2.2	1 28.0 AM	+29 01.0	0 29.0 AM	01.1	11 26.1 PM	01.1	10 27.1 PM	01.2	1 0.0	
Sept. 23				{ 0 01.5 AM 11 57.6 PM }						2 3.9	
2	2.9	1 45.4	-77 19.6	0 46.5 AM	19.7	11 43.6 PM	19.7	10 44.6	19.8	3 7.9	
Sept. 27				{ 0 03.2 AM 11 59.3 PM }						4 11.8	
3- 4	2.2	2 03.1	-18 03.4	1 04.2 AM	03.4	0 05.2 AM	03.4	11 02.3 PM	03.5	5 15.7	
Oct. 2						{ 0 01.3 AM 11 57.3 PM }				6 19.7	
4	2.1	3 38.1	+89 12.0	2 39.4	12.1	1 40.7 AM	12.2	0 41.9 AM	12.3	7 23.6	
Oct. 26								{ 0 02.6 AM 11 58.7 PM }		8 27.5	
5- 6	2.2	3 26.4	+23 24.0	2 27.4	24.1	1 28.5	24.1	0 29.5 AM	24.2	9 31.5	
Oct. 23								{ 0 02.0 AM 11 58.0 PM }		10 35.4	
6-10	1.1	5 54.7	+16 29.1	4 55.7	29.2	3 56.8	29.2	2 57.8 AM	29.2	11 39.3	
7-11	0.3	6 33.4	- 8 12.7	5 34.4	12.7	4 35.4	12.7	3 36.4	12.7	12 43.2	
8-12	0.2	6 35.1	+45 59.1	5 36.2	59.1	4 37.2	59.2	3 38.2	59.2	13 47.2	
9-16	0.5v	7 13.8	+ 7 24.6	6 14.8	24.6	5 15.9	24.6	4 16.9	24.6	14 51.1	
10-17	-0.9	7 42.9	-52 40.8	6 43.9	40.8	5 45.0	40.8	4 46.0	40.8	15 55.0	
11-18	-1.6	8 03.8	-16 41.5	7 04.8	41.5	6 05.8	41.5	5 06.9	41.5	16 0.0	
12-20	0.5	8 57.7	+ 5 15.8	7 58.7	15.8	6 59.7	15.8	6 00.7	15.8	17 3.9	
13-21	1.2	9 03.5	+28 03.7	8 04.6	03.7	7 05.6	03.7	6 06.6	03.6	18 7.9	
14-25	2.2	10 45.7	- 8 35.8	9 46.7	35.8	8 47.7	35.8	7 48.8	35.8	19 11.8	
15-26	1.3	11 26.3 AM	+12 02.2	10 27.3 AM	02.2	9 28.4	02.1	8 29.4	02.1	20 15.7	
16-28	2.2	1 06.7 PM	+14 39.0	12 07.8 PM	39.0	11 08.8 AM	38.9	10 09.8	38.9	21 19.7	
17-33	1.2	2 42.6 ¹	-11 05.5	1 43.6 ¹	05.4	12 44.6 PM	05.4	11 45.7 AM	05.4	22 23.6	
18-36	2.3	3 23.9	-36 18.4	2 24.9	18.4	1 25.9	18.3	12 26.9 PM ¹	18.3	23 27.5	
19-37	0.2	3 33.0	+19 15.2	2 34.0	15.2	1 35.1	15.2	12 36.1	15.1	24 31.5	
20-41	2.3	4 51.9	+26 45.7	3 52.9	45.7	2 53.9	45.7	1 54.9	45.6	25 35.4	
21-42	1.2	5 46.2 ⁴	-26 24.3	4 47.2 ⁴	24.3	3 48.2 ⁴	24.3	2 49.3 ⁴	24.3	26 39.3	
22-46	2.1	6 51.8	+12 34.2	5 52.8	34.2	4 53.8	34.2	3 54.8	34.2	27 43.2	
23-49	0.1	7 53.8	+38 46.4	6 54.8	46.4	5 55.8	46.4	4 56.8	46.4	28 47.2	
24-50	2.1	8 11.7 ²	-26 19.0	7 12.7 ²	19.0	6 13.7 ²	19.0	5 14.7	19.0	29 51.1	
25-51	0.9	9 07.2	+ 8 50.0	8 08.2	50.0	7 09.2	50.0	6 10.3	50.0	30 55.0	
26-54	2.5	11 00.3 PM	+ 9 48.8	10 01.3	48.9	9 02.3	48.9	8 03.4	48.9	31 59.0	
27-56	1.3	0 17.4 AM	-29 41.5	11 14.5	41.6	10 15.5	41.6	9 16.6	41.6		
Sept. 5		{ 0 01.7 AM 11 57.8 PM }									
28-57	2.6	0 24.6 AM	+15 08.0	11 21.7 PM	08.1	10 22.7 PM	08.1	9 23.7 PM	08.1		
Sept. 7		{ 0 01.0 AM 11 57.1 PM }									
¹ Venus	-4.1	2 46 PM	-12	2 34 PM	-18	2 10 PM	-23	1 25 PM	-24		
² Mars	-0.8	8 21 PM	-27	7 44 PM	-26	7 15 PM	-24	6 50 PM	-22		
³ Jupiter	-2.4	0 43 AM	- 6	11 32 PM	- 7	10 26 PM	- 7	9 22 PM	- 8		
⁴ Saturn	0.8	5 25 PM	-19	4 30 PM	-19	3 35 PM	-20	2 42 PM	-20		

Footnotes indicate near proximity of a planet to a star in time of transit and declination.

For time of transit subsequent to a star's double transit and until the next tabulated date, subtract for the number of days counting from the second transit of that date. All other interpolations may be taken directly by reference to the day of the month.

STAR TABLES, MERIDIAN OF GREENWICH, CIVIL DATE AND MEAN TIME

No.	Mag.									Transit	
		Transit	Decl.	Transit	Decl.	Transit	Decl.	Transit	Decl.	Subtract for day of month	
		Nov. 1		Nov. 16		Dec. 1		Dec. 16			
		^h ^m	[°] [']	^h ^m	[']	^h ^m	[']	^h ^m	[']		^m
1- 1	2.2	9 24.2 PM	+29 01.2	8 25.3 PM	01.2	7 26.3 PM	01.3	6 27.3 PM	01.3	1	0.0
2	2.9	9 41.7	-77 19.9	8 42.7	20.0	7 43.7	20.0	6 44.7	20.0	2	3.9
3- 4	2.2	9 59.4	-18 03.5	9 00.4	03.5	8 01.4	03.6	7 02.4	03.6	3	7.9
4	2.1	11 35.2	+89 12.4	10 36.2	12.5	9 37.1	12.6	8 37.9	12.6	4	11.8
5- 6	2.2	11 22.6 PM	+23 24.2	10 23.7 PM	24.2	9 24.7	24.2	8 25.7	24.2	5	15.7
6-10	1.1	1 54.9 AM	+16 29.2	0 55.9 AM { 0 00.9 AM 11 57.0 PM }	29.2	11 53.0 PM	29.2	10 54.0	29.2	6	19.7
Nov. 30										7	23.6
7-11	0.3	2 33.5	- 8 12.7	1 34.6 AM	12.7	0 35.6 AM { 0 00.2 AM 11 56.3 PM }	12.8	11 32.7	12.8	8	27.5
Dec. 10										9	31.5
8-12	0.2	2 35.3	+45 59.2	1 36.4	59.2	0 37.4 AM { 0 02.0 AM 11 58.1 PM }	59.3	11 34.5 PM	59.3	10	35.4
Dec. 10										11	39.3
9-16	0.5 _v	3 14.0	+ 7 24.5	2 15.0	24.5	1 16.0 AM	24.5	0 17.1 AM { 0 01.3 AM 11 57.4 PM }	24.5	12	43.2
Dec. 20										13	47.2
10-17	-0.9	3 43.1	-52 40.9	2 44.1	40.9	1 45.2	41.0	0 46.2 AM { 0 02.9 AM 11 59.0 PM }	41.1	14	51.1
Dec. 27										15	55.0
11-18	-1.6	4 04.0	-16 41.5	3 05.0	41.6	2 06.0	41.6	1 07.0 AM	41.7	16	0.0
12-20	0.5	4 57.8	+ 5 15.8	3 58.9	15.8	2 59.9	15.7	2 00.9	15.7	17	3.9
13-21	1.2	5 03.7	+28 03.6	4 04.8	03.6	3 05.8	03.6	2 06.8	03.6	18	7.9
14-25	2.2	6 45.9	- 8 35.8	5 46.9	35.8	4 47.9	35.9	3 49.0	35.9	19	11.8
15-26	1.3	7 26.5	+12 02.1	6 27.5	02.0	5 28.5	02.0	4 29.6	01.9	20	15.7
16-28	2.2	9 06.9	+14 38.8	8 07.9	38.8	7 09.0	38.7	6 10.0	38.7	21	19.7
17-33	1.2	10 42.8	-11 05.5	9 43.8 ¹	05.5	8 44.8 ¹	05.5	7 45.8	05.6	22	23.6
18-36	2.3	11 24.0	-36 18.3	10 25.1	18.2	9 26.1	18.2	8 27.1	18.2	23	27.5
19-37	0.2	11 33.2 AM	+19 15.1	10 34.2	15.0	9 35.2	15.0	8 36.3	14.9	24	31.5
20-41	2.3	12 52.0 PM	+26 45.5	11 53.1 AM	45.5	10 54.1	45.4	9 55.1	45.3	25	35.4
21-42	1.2	1 46.3 ⁴	-26 24.3	12 47.4 PM ⁴	24.3	11 48.4 AM ⁴	24.3	10 49.4 ⁴	24.3	26	39.3
22-46	2.1	2 51.9	+12 34.1	1 52.9	34.1	12 53.9 PM	34.1	11 55.0 AM	34.0	27	43.2
23-49	0.1	3 53.9	+38 46.4	2 54.9	46.3	1 55.9	46.3	12 57.0 PM	46.2	28	47.2
24-50	2.1	4 11.8	-26 19.0	3 12.8	19.0	2 13.9	19.0	1 14.9	19.0	29	51.1
25-51	0.9	5 07.4	+ 8 50.0	4 08.4	50.0	3 09.4	49.9	2 10.4	49.9	30	55.0
26-54	2.5	7 00.5	+ 9 48.9	6 01.5	48.9	5 02.5	48.9	4 03.5	48.9	31	59.0
27-56	1.3	8 13.7	-29 41.7	7 14.7	41.7	6 15.7	41.7	5 16.7	41.7		
28-57	2.6	8 20.8 PM	+15 08.1	7 21.8 PM	08.1	6 22.8 PM	08.1	5 23.9 PM	08.1		
¹ Venus	-4.0	12 01 PM	-22 [°]	10 34 AM	-16 [°]	9 34 AM	-12 [°]	9 03 AM	-13 [°]		
² Mars	0.3	6 26 PM	-19	6 05 PM	-15	5 44 PM	-11	5 23 PM	- 7		
³ Jupiter	-2.1	8 16 PM	- 8	7 18 PM	- 8	6 21 PM	- 8	5 28 PM	- 7		
⁴ Saturn	0.7	1 45 PM	-20	12 53 PM	-20	12 02 PM	-21	11 10 AM	-21		

Footnotes indicate near proximity of a planet to a star in time of transit and declination.

For reduction of time of transit from the Greenwich mean time to the local mean time at the longitude of the station, see table of Sidereal Conversions, page 27.

Mean Time Hour Angle	AZIMUTH OF POLARIS AT ALL HOUR ANGLES, 1986												CORR. TO AZIMUTH		
	Mean Declination + 89° 12' 20"												Add for Decl. + 89°		
													12'10"	12'00"	11'50"
	Latitude												Subtract for Decl. + 89°		
	10°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°		12'30"	12'40"	12'50"
h m	/	/	/	/	/	/	/	/	/	/	/		/	/	/
0 00.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
0 10.0	2.1	2.1	2.2	2.2	2.2	2.2	2.3	2.3	2.3	2.4	2.4		0.0	0.0	0.0
19.9	4.2	4.3	4.3	4.3	4.4	4.4	4.5	4.6	4.7	4.7	4.8		0.0	0.0	0.0
29.9	6.3	6.4	6.4	6.5	6.6	6.7	6.7	6.9	7.0	7.1	7.2		0.0	0.0	0.1
0 39.9	8.4	8.5	8.6	8.6	8.7	8.9	9.0	9.1	9.3	9.4	9.6		0.0	0.1	0.1
49.9	10.5	10.6	10.7	10.8	10.9	11.0	11.2	11.4	11.6	11.8	12.0		0.0	0.1	0.1
59.8	12.6	12.6	12.8	12.9	13.0	13.2	13.4	13.6	13.8	14.1	14.4		0.0	0.1	0.1
1 09.8	14.6	14.7	14.8	15.0	15.1	15.3	15.5	15.8	16.1	16.3	16.7		0.1	0.1	0.2
19.8	16.6	16.7	16.9	17.0	17.2	17.4	17.7	18.0	18.3	18.6	19.0		0.1	0.1	0.2
29.8	18.6	18.7	18.9	19.0	19.3	19.5	19.8	20.1	20.4	20.8	21.2		0.1	0.1	0.2
1 39.7	20.5	20.7	20.8	21.0	21.3	21.5	21.8	22.2	22.6	23.0	23.4		0.1	0.2	0.2
49.7	22.4	22.6	22.8	23.0	23.2	23.5	23.9	24.2	24.6	25.1	25.6		0.1	0.2	0.2
59.7	24.3	24.4	24.6	24.9	25.2	25.5	25.8	26.2	26.7	27.2	27.7		0.1	0.2	0.3
2 09.6	26.1	26.2	26.5	26.7	27.0	27.4	27.8	28.2	28.7	29.2	29.8		0.1	0.2	0.3
19.6	27.8	28.0	28.3	28.5	28.9	29.2	29.6	30.1	30.6	31.2	31.8		0.1	0.2	0.3
29.6	29.5	29.7	30.0	30.3	30.6	31.0	31.4	31.9	32.5	33.1	33.7		0.1	0.2	0.3
2 39.6	31.2	31.4	31.7	32.0	32.3	32.7	33.2	33.7	34.3	34.9	35.6		0.1	0.2	0.3
49.5	32.8	33.0	33.3	33.6	34.0	34.4	34.9	35.4	36.0	36.7	37.4		0.1	0.2	0.4
59.5	34.3	34.5	34.8	35.2	35.6	36.0	36.5	37.1	37.7	38.4	39.1		0.1	0.3	0.4
3 09.5	35.7	36.0	36.3	36.7	37.1	37.5	38.0	38.6	39.3	40.0	40.8		0.1	0.3	0.4
19.5	37.1	37.4	37.7	38.1	38.5	39.0	39.5	40.1	40.8	41.6	42.4		0.1	0.3	0.4
29.4	38.5	38.7	39.1	39.4	39.9	40.4	40.9	41.6	42.2	43.0	43.9		0.1	0.3	0.4
3 39.4	39.7	40.0	40.3	40.7	41.2	41.7	42.2	42.9	43.6	44.4	45.3		0.1	0.3	0.4
49.4	40.9	41.2	41.5	41.9	42.4	42.9	43.5	44.2	44.9	45.7	46.6		0.1	0.3	0.4
59.3	42.0	42.3	42.6	43.0	43.5	44.0	44.6	45.3	46.1	46.9	47.9		0.2	0.3	0.5
4 09.3	43.0	43.3	43.6	44.1	44.5	45.1	45.7	46.4	47.2	48.0	49.0		0.2	0.3	0.5
19.3	43.9	44.2	44.6	45.0	45.5	46.1	46.7	47.4	48.2	49.1	50.1		0.2	0.3	0.5
29.3	44.8	45.1	45.4	45.9	46.4	47.0	47.6	48.3	49.1	50.0	51.0		0.2	0.3	0.5
4 39.2	45.5	45.8	46.2	46.7	47.2	47.7	48.4	49.1	50.0	50.9	51.9		0.2	0.3	0.5
49.2	46.2	46.5	46.9	47.3	47.9	48.5	49.1	49.9	50.7	51.6	52.6		0.2	0.3	0.5
59.2	46.8	47.1	47.5	47.9	48.5	49.1	49.7	50.5	51.3	52.2	53.3		0.2	0.3	0.5
5 09.2	47.3	47.6	48.0	48.5	49.0	49.6	50.3	51.0	51.9	52.8	53.8		0.2	0.3	0.5
19.1	47.7	48.0	48.4	48.9	49.4	50.0	50.7	51.4	52.3	53.2	54.3		0.2	0.3	0.5
29.1	48.0	48.3	48.7	49.2	49.7	50.3	51.0	51.8	52.6	53.6	54.6		0.2	0.4	0.5
5 39.1	48.2	48.6	49.0	49.4	49.9	50.6	51.2	52.0	52.9	53.8	54.9		0.2	0.4	0.5
49.0	48.4	48.7	49.1	49.5	50.1	50.7	51.4	52.1	53.0	54.0	55.0		0.2	0.4	0.5
57.2	...	...	...	...	...	...	...	...	...	...	55.0		0.2	0.4	0.6
5 57.3	...	...	...	...	...	...	...	...	...	54.0	...		0.2	0.4	0.6
57.5	...	...	...	...	...	...	...	...	53.0	...	...		0.2	0.4	0.6
57.6	...	...	...	...	...	...	...	52.2	...	...	...		0.2	0.4	0.5
5 57.7	...	...	...	...	...	...	51.4	...	...	...	...		0.2	0.4	0.5
57.9	...	...	...	...	...	50.7	...	...	...	...	...		0.2	0.4	0.5
58.0	...	...	...	...	50.1	...	...	...	...	...	...		0.2	0.4	0.5
5 58.1	...	...	...	49.6	...	...	...	...	...	...	...		0.2	0.3	0.5
58.2	...	...	49.1	...	...	...	...	...	...	...	...		0.2	0.3	0.5
58.3	...	48.7	...	...	...	...	...	...	...	...	...		0.2	0.3	0.5
5 58.5	48.4	...	...	...	...	...	...	...	...	...	...		0.2	0.3	0.5

See footnote pages 18 and 19 for equation to be employed when values in seconds are required.

Mean Time Hour Angle	AZIMUTH OF POLARIS AT ALL HOUR ANGLES, 1986												CORR. TO AZIMUTH		
	Mean Declination + 89° 12' 20"												Add for Decl. + 89°		
													12'10"	12'00"	11'50"
	Latitude												Subtract for Decl. + 89°		
	10°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°		12'30"	12'40"	12'50"
h m	/	/	/	/	/	/	/	/	/	/	/		/	/	/
5 57.2	...	...	...	...	...	...	...	...	...	...	55.0		0.2	0.4	0.6
57.3	...	...	...	...	...	...	...	...	...	54.0	...		0.2	0.4	0.6
57.5	...	...	...	...	...	...	...	...	53.0	...	...		0.2	0.4	0.6
5 57.6	...	...	...	...	...	...	...	52.2	...	...	...		0.2	0.4	0.5
57.7	...	...	...	...	...	...	51.4	...	...	...	...		0.2	0.4	0.5
57.9	...	...	...	...	...	50.7	...	...	...	...	...		0.2	0.4	0.5
5 58.0	...	...	...	...	50.1	...	...	...	...	...	...		0.2	0.4	0.5
58.1	...	...	...	49.6	...	...	...	...	...	...	...		0.2	0.3	0.5
58.2	...	...	49.1	...	...	...	...	...	...	...	...		0.2	0.3	0.5
5 58.3	...	48.7	...	...	...	...	...	...	...	...	...		0.2	0.3	0.5
58.5	48.4	...	...	...	...	...	...	...	...	...	...		0.2	0.3	0.5
59.0	48.4	48.7	49.1	49.6	50.1	50.7	51.4	52.2	53.0	54.0	55.0		0.2	0.4	0.5
6 09.0	48.4	48.7	49.1	49.5	50.1	50.7	51.3	52.1	53.0	53.9	55.0		0.2	0.4	0.5
19.0	48.2	48.5	48.9	49.4	49.9	50.5	51.2	52.0	52.8	53.7	54.8		0.2	0.4	0.5
28.9	48.0	48.3	48.7	49.1	49.7	50.3	50.9	51.7	52.5	53.5	54.5		0.2	0.4	0.5
6 38.9	47.6	48.0	48.4	48.8	49.3	49.9	50.6	51.3	52.2	53.1	54.1		0.2	0.3	0.5
48.9	47.2	47.5	47.9	48.4	48.9	49.5	50.1	50.9	51.7	52.6	53.6		0.2	0.3	0.5
58.9	46.7	47.0	47.4	47.8	48.4	48.9	49.6	50.3	51.1	52.0	53.1		0.2	0.3	0.5
7 08.8	46.1	46.4	46.8	47.2	47.7	48.3	48.9	49.7	50.5	51.4	52.4		0.2	0.3	0.5
18.8	45.4	45.7	46.1	46.5	47.0	47.6	48.2	48.9	49.7	50.6	51.6		0.2	0.3	0.5
28.8	44.7	45.0	45.3	45.7	46.2	46.8	47.4	48.1	48.9	49.7	50.7		0.2	0.3	0.5
7 38.7	43.8	44.1	44.5	44.9	45.3	45.9	46.5	47.2	47.9	48.8	49.7		0.2	0.3	0.5
48.7	42.9	43.2	43.5	43.9	44.4	44.9	45.5	46.2	46.9	47.7	48.6		0.2	0.3	0.5
58.7	41.9	42.1	42.5	42.9	43.3	43.8	44.4	45.0	45.8	46.6	47.5		0.2	0.3	0.5
8 08.7	40.8	41.0	41.4	41.7	42.2	42.7	43.2	43.9	44.6	45.4	46.2		0.1	0.3	0.4
18.6	39.6	39.9	40.2	40.5	41.0	41.4	42.0	42.6	43.3	44.0	44.9		0.1	0.3	0.4
28.6	38.3	38.6	38.9	39.2	39.7	40.1	40.6	41.2	41.9	42.6	43.5		0.1	0.3	0.4
8 38.6	37.0	37.3	37.6	37.9	38.3	38.7	39.2	39.8	40.5	41.2	41.9		0.1	0.3	0.4
48.6	35.6	35.9	36.1	36.5	36.8	37.3	37.8	38.3	38.9	39.6	40.4		0.1	0.3	0.4
58.5	34.2	34.4	34.7	35.0	35.3	35.7	36.2	36.7	37.3	38.0	38.7		0.1	0.2	0.4
9 08.5	32.6	32.9	33.1	33.4	33.7	34.1	34.6	35.1	35.7	36.3	37.0		0.1	0.2	0.4
18.5	31.1	31.3	31.5	31.8	32.1	32.5	32.9	33.4	33.9	34.5	35.2		0.1	0.2	0.3
28.4	29.4	29.6	29.8	30.1	30.4	30.8	31.2	31.6	32.1	32.7	33.3		0.1	0.2	0.3
9 38.4	27.7	27.9	28.1	28.4	28.6	29.0	29.4	29.8	30.3	30.8	31.4		0.1	0.2	0.3
48.4	26.0	26.1	26.3	26.6	26.8	27.1	27.5	27.9	28.3	28.8	29.4		0.1	0.2	0.3
58.4	24.2	24.3	24.5	24.7	25.0	25.3	25.6	26.0	26.4	26.8	27.3		0.1	0.2	0.3
10 08.3	22.3	22.4	22.6	22.8	23.1	23.3	23.6	24.0	24.3	24.8	25.2		0.1	0.2	0.2
18.3	20.4	20.5	20.7	20.9	21.1	21.3	21.6	21.9	22.3	22.7	23.1		0.1	0.1	0.2
28.3	18.5	18.6	18.7	18.9	19.1	19.3	19.6	19.9	20.2	20.5	20.9		0.1	0.1	0.2
10 38.3	16.5	16.6	16.7	16.9	17.1	17.3	17.5	17.7	18.0	18.3	18.7		0.1	0.1	0.2
48.2	14.5	14.6	14.7	14.9	15.0	15.2	15.4	15.6	15.8	16.1	16.4		0.1	0.1	0.2
58.2	12.5	12.6	12.7	12.8	12.9	13.1	13.2	13.4	13.6	13.9	14.1		0.0	0.1	0.1
11 08.2	10.5	10.5	10.6	10.7	10.8	10.9	11.1	11.2	11.4	11.6	11.8		0.0	0.1	0.1
18.1	8.4	8.4	8.5	8.6	8.7	8.8	8.9	9.0	9.1	9.3	9.5		0.0	0.1	0.1
28.1	6.3	6.3	6.4	6.4	6.5	6.6	6.7	6.8	6.9	7.0	7.1		0.0	0.0	0.1
11 38.1	4.2	4.2	4.3	4.3	4.3	4.4	4.5	4.5	4.6	4.7	4.8		0.0	0.0	0.0
48.1	2.1	2.1	2.1	2.2	2.2	2.2	2.2	2.3	2.3	2.3	2.4		0.0	0.0	0.0
58.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0

See footnote pages 18 and 19 for equation to be employed when values in seconds are required.

Mean Time Hour Angle	AZIMUTH OF POLARIS AT ALL HOUR ANGLES, 1986												CORR. TO AZIMUTH		
	Mean Declination + 89° 12' 20"												Add for Decl. + 89°		
													12'10"	12'00"	11'50"
	Latitude												Subtract for Decl. + 89°		
	30°	32°	34°	36°	38°	40°	42°	44°	46°	48°	50°		12'30"	12'40"	12'50"
h m	/	/	/	/	/	/	/	/	/	/	/		/	/	/
0 00.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
0 10.0	2.4	2.5	2.5	2.6	2.7	2.7	2.8	2.9	3.0	3.2	3.3		0.0	0.0	0.0
19.9	4.8	4.9	5.1	5.2	5.3	5.5	5.7	5.9	6.1	6.3	6.6		0.0	0.0	0.1
29.9	7.2	7.4	7.6	7.8	8.0	8.2	8.5	8.8	9.1	9.4	9.8		0.0	0.1	0.1
0 39.9	9.6	9.8	10.1	10.3	10.6	10.9	11.3	11.7	12.1	12.6	13.1		0.0	0.1	0.1
49.9	12.0	12.3	12.6	12.9	13.2	13.6	14.1	14.5	15.1	15.7	16.3		0.0	0.1	0.1
59.8	14.4	14.7	15.0	15.4	15.8	16.3	16.8	17.4	18.0	18.7	19.5		0.1	0.1	0.2
1 09.8	16.7	17.0	17.4	17.9	18.4	18.9	19.5	20.2	20.9	21.7	22.7		0.1	0.1	0.2
19.8	19.0	19.4	19.8	20.3	20.9	21.5	22.2	23.0	23.8	24.7	25.8		0.1	0.2	0.2
29.8	21.2	21.7	22.2	22.8	23.4	24.1	24.8	25.7	26.6	27.7	28.8		0.1	0.2	0.3
1 39.7	23.4	23.9	24.5	25.1	25.8	26.6	27.4	28.3	29.4	30.5	31.8		0.1	0.2	0.3
49.7	25.6	26.2	26.8	27.5	28.2	29.0	30.0	31.0	32.1	33.4	34.8		0.1	0.2	0.3
59.7	27.7	28.3	29.0	29.7	30.5	31.4	32.4	33.5	34.7	36.1	37.6		0.1	0.2	0.3
2 09.6	29.8	30.4	31.1	31.9	32.8	33.8	34.8	36.0	37.3	38.8	40.4		0.1	0.2	0.4
19.6	31.8	32.5	33.2	34.1	35.0	36.0	37.2	38.4	39.8	41.4	43.1		0.1	0.3	0.4
29.6	33.7	34.5	35.3	36.2	37.1	38.2	39.4	40.8	42.3	43.9	45.7		0.1	0.3	0.4
2 39.6	35.6	36.4	37.2	38.2	39.2	40.4	41.6	43.0	44.6	46.3	48.3		0.1	0.3	0.4
49.5	37.4	38.2	39.1	40.1	41.2	42.4	43.7	45.2	46.9	48.7	50.7		0.1	0.3	0.4
59.5	39.1	40.0	40.9	42.0	43.1	44.4	45.8	47.3	49.0	50.9	53.1		0.2	0.3	0.5
3 09.5	40.8	41.7	42.7	43.7	44.9	46.2	47.7	49.3	51.1	53.1	55.3		0.2	0.3	0.5
19.5	42.4	43.3	44.3	45.4	46.7	48.0	49.5	51.2	53.1	55.1	57.4		0.2	0.3	0.5
29.4	43.9	44.8	45.9	47.0	48.3	49.7	51.3	53.0	54.9	57.0	59.4		0.2	0.3	0.5
3 39.4	45.3	46.3	47.4	48.5	49.9	51.3	52.9	54.7	56.7	58.9	61.3		0.2	0.4	0.5
49.4	46.6	47.6	48.7	50.0	51.3	52.8	54.5	56.3	58.3	60.6	63.1		0.2	0.4	0.6
59.3	47.9	48.9	50.0	51.3	52.7	54.2	55.9	57.8	59.9	62.2	64.8		0.2	0.4	0.6
4 09.3	49.0	50.1	51.2	52.5	53.9	55.5	57.2	59.1	61.3	63.6	66.3		0.2	0.4	0.6
19.3	50.1	51.1	52.3	53.6	55.1	56.7	58.4	60.4	62.6	65.0	67.7		0.2	0.4	0.6
29.3	51.0	52.1	53.3	54.6	56.1	57.7	59.5	61.5	63.7	66.2	68.9		0.2	0.4	0.6
4 39.2	51.9	53.0	54.2	55.6	57.1	58.7	60.5	62.6	64.8	67.3	70.1		0.2	0.4	0.6
49.2	52.6	53.7	55.0	56.4	57.9	59.6	61.4	63.4	65.7	68.3	71.1		0.2	0.4	0.6
59.2	53.3	54.4	55.7	57.1	58.6	60.3	62.2	64.2	66.5	69.1	71.9		0.2	0.4	0.6
5 09.2	53.8	55.0	56.2	57.6	59.2	60.9	62.8	64.9	67.2	69.8	72.7		0.2	0.4	0.6
19.1	54.3	55.4	56.7	58.1	59.7	61.4	63.3	65.4	67.7	70.3	73.2		0.2	0.4	0.6
29.1	54.6	55.8	57.1	58.5	60.1	61.8	63.7	65.8	68.2	70.8	73.7		0.2	0.4	0.6
5 39.1	54.9	56.0	57.3	58.7	60.3	62.0	64.0	66.1	68.4	71.1	74.0		0.2	0.4	0.7
49.0	55.0	56.2	57.5	58.9	60.5	62.2	64.1	66.2	68.6	71.2	74.1		0.2	0.4	0.7
55.2	...	...	...	...	...	...	...	...	...	...	74.2		0.3	0.5	0.8
5 55.5	...	...	...	...	...	...	...	...	...	71.2	...		0.2	0.5	0.7
55.7	...	...	...	...	...	...	...	...	68.6	...	...		0.2	0.5	0.7
56.0	...	...	...	...	...	...	...	66.3	...	...	...		0.2	0.5	0.7
5 56.2	...	...	...	...	...	...	64.1	...	...	...	...		0.2	0.4	0.7
56.4	...	...	...	...	...	62.2	...	...	...	...	...		0.2	0.4	0.7
56.5	...	...	...	...	60.5	...	...	...	...	...	...		0.2	0.4	0.6
5 56.7	...	...	...	58.9	...	...	...	...	...	...	...		0.2	0.4	0.6
56.9	...	...	57.5	...	...	...	...	...	...	...	...		0.2	0.4	0.6
57.0	...	56.2	...	...	...	...	...	...	...	...	...		0.2	0.4	0.6
5 57.2	55.0	...	...	...	...	...	...	...	...	...	...		0.2	0.4	0.6

Note: The equation shown on the opposite page may be employed when values in seconds are required, also for stations beyond the limits of the latitude tabulations, where:

- A = Azimuth angle
- t = Sidereal hour angle
- φ = Latitude of station
- δ = Declination of Polaris

Mean Time Hour Angle		AZIMUTH OF POLARIS AT ALL HOUR ANGLES, 1986											CORR. TO AZIMUTH		
		Mean Declination + 89° 12' 20"											Add for Decl. + 89°		
													12'10"	12'00"	11'50"
		Latitude											Subtract for Decl. + 89°		
		30°	32°	34°	36°	38°	40°	42°	44°	46°	48°	50°	12'30"	12'40"	12'50"
h	m	/	/	/	/	/	/	/	/	/	/	/	/	/	/
5	55.2	...	...	...	...	...	...	...	...	...	...	74.2	0.3	0.5	0.8
	55.5	...	...	...	...	...	...	...	...	...	...	71.2	0.2	0.5	0.7
	55.7	...	...	...	...	...	...	...	...	68.6	...	...	0.2	0.5	0.7
5	56.0	...	...	...	...	...	...	...	66.3	...	...	...	0.2	0.5	0.7
	56.2	...	...	...	...	...	...	64.1	...	...	...	...	0.2	0.4	0.7
	56.4	...	...	...	...	...	62.2	...	...	...	...	...	0.2	0.4	0.7
5	56.5	...	...	...	...	60.5	...	...	...	...	...	...	0.2	0.4	0.6
	56.7	...	...	...	58.9	...	...	...	...	...	...	...	0.2	0.4	0.6
	56.9	...	...	57.5	...	...	...	...	...	...	...	...	0.2	0.4	0.6
5	57.0	...	56.2	...	...	...	...	...	...	...	...	...	0.2	0.4	0.6
	57.2	55.0	...	...	...	...	...	...	...	...	...	...	0.2	0.4	0.6
	59.0	55.0	56.2	57.5	58.9	60.5	62.2	64.1	66.3	68.6	71.2	74.1	0.2	0.4	0.7
6	09.0	55.0	56.1	57.4	58.8	60.4	62.1	64.0	66.2	68.5	71.1	74.0	0.2	0.4	0.7
	19.0	54.8	56.0	57.2	58.6	60.2	61.9	63.8	65.9	68.3	70.9	73.8	0.2	0.4	0.6
	28.9	54.5	55.7	56.9	58.3	59.9	61.6	63.5	65.6	67.9	70.5	73.4	0.2	0.4	0.6
6	38.9	54.1	55.3	56.5	57.9	59.5	61.2	63.0	65.1	67.4	70.0	72.8	0.2	0.4	0.6
	48.9	53.6	54.8	56.0	57.4	58.9	60.6	62.4	64.5	66.8	69.3	72.1	0.2	0.4	0.6
	58.9	53.1	54.2	55.4	56.8	58.3	59.9	61.8	63.8	66.0	68.5	71.3	0.2	0.4	0.6
7	08.8	52.4	53.5	54.7	56.0	57.5	59.1	60.9	62.9	65.2	67.6	70.4	0.2	0.4	0.6
	18.8	51.6	52.7	53.9	55.2	56.6	58.2	60.0	62.0	64.2	66.6	69.3	0.2	0.4	0.6
	28.8	50.7	51.8	52.9	54.2	55.7	57.2	59.0	60.9	63.0	65.4	68.1	0.2	0.4	0.6
7	38.7	49.7	50.8	51.9	53.2	54.6	56.1	57.8	59.7	61.8	64.1	66.7	0.2	0.4	0.6
	48.7	48.6	49.7	50.8	52.0	53.4	54.9	56.6	58.4	60.5	62.7	65.3	0.2	0.4	0.6
	58.7	47.5	48.5	49.6	50.8	52.1	53.6	55.2	57.0	59.0	61.2	63.7	0.2	0.4	0.6
8	08.7	46.2	47.2	48.2	49.4	50.7	52.2	53.7	55.5	57.4	59.6	62.0	0.2	0.4	0.5
	18.6	44.9	45.8	46.8	48.0	49.2	50.6	52.2	53.9	55.7	57.8	60.2	0.2	0.4	0.5
	28.6	43.5	44.4	45.4	46.5	47.7	49.0	50.5	52.1	54.0	56.0	58.2	0.2	0.3	0.5
8	38.6	41.9	42.8	43.8	44.8	46.0	47.3	48.7	50.3	52.1	54.0	56.2	0.2	0.3	0.5
	48.6	40.4	41.2	42.1	43.1	44.3	45.5	46.9	48.4	50.1	52.0	54.1	0.2	0.3	0.5
	58.5	38.7	39.5	40.4	41.4	42.4	43.6	45.0	46.4	48.0	49.8	51.8	0.2	0.3	0.5
9	08.5	37.0	37.7	38.6	39.5	40.5	41.7	42.9	44.3	45.9	47.6	49.5	0.1	0.3	0.4
	18.5	35.2	35.9	36.7	37.6	38.6	39.6	40.8	42.2	43.6	45.3	47.1	0.1	0.3	0.4
	28.4	33.3	34.0	34.7	35.6	36.5	37.5	38.7	39.9	41.3	42.8	44.6	0.1	0.3	0.4
9	38.4	31.4	32.0	32.7	33.5	34.4	35.4	36.4	37.6	38.9	40.4	42.0	0.1	0.2	0.4
	48.4	29.4	30.0	30.7	31.4	32.2	33.1	34.1	35.2	36.4	37.8	39.3	0.1	0.2	0.3
	58.4	27.3	27.9	28.5	29.2	30.0	30.8	31.7	32.8	33.9	35.2	36.6	0.1	0.2	0.3
10	08.3	25.2	25.8	26.3	27.0	27.7	28.4	29.3	30.2	31.3	32.5	33.7	0.1	0.2	0.3
	18.3	23.1	23.6	24.1	24.7	25.3	26.0	26.8	27.7	28.6	29.7	30.9	0.1	0.2	0.3
	28.3	20.9	21.3	21.8	22.3	22.9	23.6	24.3	25.0	25.9	26.9	28.0	0.1	0.2	0.2
10	38.3	18.7	19.1	19.5	20.0	20.5	21.1	21.7	22.4	23.2	24.0	25.0	0.1	0.1	0.2
	48.2	16.4	16.8	17.1	17.5	18.0	18.5	19.1	19.7	20.4	21.1	22.0	0.1	0.1	0.2
	58.2	14.1	14.4	14.7	15.1	15.5	15.9	16.4	16.9	17.5	18.2	18.9	0.1	0.1	0.2
11	08.2	11.8	12.1	12.3	12.6	13.0	13.3	13.7	14.2	14.6	15.2	15.8	0.0	0.1	0.1
	18.1	9.5	9.7	9.9	10.1	10.4	10.7	11.0	11.4	11.8	12.2	12.7	0.0	0.1	0.1
	28.1	7.1	7.3	7.4	7.6	7.8	8.0	8.3	8.5	8.8	9.2	9.5	0.0	0.1	0.1
11	38.1	4.8	4.9	5.0	5.1	5.2	5.4	5.5	5.7	5.9	6.1	6.4	0.0	0.0	0.1
	48.1	2.4	2.4	2.5	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2	0.0	0.0	0.0
	58.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Tan A =

sin t

cos ϕ tan δ − sin ϕ cos t

The product, sin ϕ cos t, is subtracted for hour angles
0° to 90° and added for hour angles from 90° to 180°.

Mean Time Hour Angle	AZIMUTH OF POLARIS AT ALL HOUR ANGLES, 1986												CORR. TO AZIMUTH		
	Mean Declination + 89° 12' 20"												Add for Decl. + 89°		
													12'10"	12'00"	11'50"
	Latitude												Subtract for Decl. + 89°		
	50°	52°	54°	56°	58°	60°	61°	62°	63°	64°	65°	Az.	12'30"	12'40"	12'50"
h m	/	/	/	/	/	/	/	/	/	/	/	°	/	/	/
0 00.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0
0 10.0	3.3	3.4	3.6	3.8	4.0	4.3	4.4	4.5	4.7	4.9	5.1		0.0	0.0	0.0
19.9	6.6	6.9	7.2	7.6	8.0	8.5	8.8	9.1	9.4	9.8	10.1		0.0	0.1	0.1
29.9	9.8	10.3	10.8	11.4	12.0	12.7	13.2	13.6	14.1	14.6	15.2		0.0	0.1	0.1
0 39.9	13.1	13.7	14.4	15.1	16.0	17.0	17.5	18.1	18.7	19.4	20.2		0.1	0.1	0.2
49.9	16.3	17.1	17.9	18.8	19.9	21.1	21.8	22.6	23.3	24.2	25.1		0.1	0.1	0.2
59.8	19.5	20.4	21.4	22.5	23.8	25.3	26.1	27.0	27.9	28.9	30.1		0.1	0.2	0.2
1 09.8	22.7	23.7	24.8	26.1	27.6	29.3	30.3	31.3	32.4	33.6	34.9		0.1	0.2	0.3
19.8	25.8	26.9	28.2	29.7	31.4	33.4	34.4	35.6	36.9	38.2	39.7		0.1	0.2	0.3
29.8	28.8	30.1	31.6	33.3	35.1	37.3	38.5	39.8	41.2	42.7	44.4		0.1	0.2	0.4
1 39.7	31.8	33.3	34.9	36.7	38.8	41.2	42.5	43.9	45.5	47.2	49.0		0.1	0.3	0.4
49.7	34.8	36.3	38.1	40.1	42.4	45.0	46.4	48.0	49.7	51.5	53.5		0.1	0.3	0.4
59.7	37.6	39.3	41.2	43.4	45.9	48.7	50.2	51.9	53.8	55.7	57.9	0	0.2	0.3	0.5
2 09.6	40.4	42.2	44.3	46.6	49.3	52.3	54.0	55.8	57.7	59.9	2.2	1	0.2	0.3	0.5
19.6	43.1	45.1	47.3	49.7	52.5	55.8	57.6	59.5	1.6	3.9	6.3		0.2	0.4	0.6
29.6	45.7	47.8	50.1	52.8	55.7	59.2	1.1	3.1	5.3	7.7	10.3		0.2	0.4	0.6
2 39.6	48.3	50.5	52.9	55.7	58.8	2.4	4.4	6.6	8.9	11.4	14.2		0.2	0.4	0.6
49.5	50.7	53.0	55.6	58.5	1.8	5.6	7.7	9.9	12.4	15.0	17.9		0.2	0.4	0.6
59.5	53.1	55.4	58.1	1.2	4.6	8.6	10.8	13.1	15.7	18.5	21.5		0.2	0.5	0.7
3 09.5	55.3	57.8	0.6	3.7	7.3	11.4	13.7	16.2	18.9	21.7	24.8		0.2	0.5	0.7
19.5	57.4	60.0	2.9	6.2	9.9	14.2	16.5	19.1	21.9	24.8	28.1		0.2	0.5	0.7
29.4	59.4	2.1	5.1	8.5	12.3	16.7	19.2	21.8	24.7	27.8	31.1		0.3	0.5	0.8
3 39.4	1.3	4.1	7.2	10.7	14.6	19.2	21.7	24.4	27.4	30.5	34.0		0.3	0.5	0.8
49.4	3.1	5.9	9.1	12.7	16.8	21.4	24.0	26.8	29.9	33.1	36.7		0.3	0.5	0.8
59.3	4.8	7.6	10.9	14.6	18.8	23.6	26.2	29.1	32.2	35.5	39.1		0.3	0.6	0.8
4 09.3	6.3	9.2	12.6	16.3	20.6	25.5	28.2	31.1	34.3	37.7	41.4		0.3	0.6	0.8
19.3	7.7	10.7	14.1	17.9	22.3	27.3	30.0	33.0	36.2	39.7	43.5		0.3	0.6	0.9
29.3	8.9	12.0	15.5	19.4	23.8	28.9	31.7	34.7	38.0	41.5	45.4		0.3	0.6	0.9
4 39.2	10.1	13.2	16.7	20.7	25.2	30.3	33.2	36.2	39.6	43.2	47.0		0.3	0.6	0.9
49.2	11.1	14.2	17.8	21.8	26.4	31.6	34.5	37.6	40.9	44.6	48.5		0.3	0.6	0.9
59.2	11.9	15.1	18.7	22.8	27.4	32.6	35.6	38.7	42.1	45.8	49.8		0.3	0.6	0.9
5 09.2	12.7	15.9	19.5	23.6	28.2	33.5	36.5	39.7	43.1	46.8	50.8		0.3	0.6	0.9
19.1	13.2	16.5	20.1	24.2	28.9	34.3	37.2	40.4	43.9	47.6	51.6		0.3	0.6	0.9
29.1	13.7	16.9	20.6	24.7	29.4	34.8	37.8	41.0	44.4	48.2	52.2		0.3	0.6	0.9
5 39.1	14.0	17.2	20.9	25.1	29.8	35.2	38.1	41.4	44.8	48.6	52.6		0.3	0.6	0.9
49.0	14.1	17.4	21.1	25.2	29.9	35.3	38.3	41.5	45.0	48.7	52.8		0.3	0.6	0.9
52.2	...	...	...	...	...	...	...	...	...	...	52.8		0.4	0.8	1.2
5 52.5	...	...	...	...	...	...	...	...	...	48.8	...		0.4	0.8	1.1
52.8	...	...	...	...	...	...	...	...	45.0	...	...		0.4	0.7	1.1
53.1	...	...	...	...	...	...	...	41.5	...	...	...		0.4	0.7	1.1
5 53.3	...	...	...	...	...	...	38.3	...	...	...	...		0.3	0.7	1.0
53.5	...	...	...	...	...	35.3	...	...	...	...	...		0.3	0.7	1.0
53.9	...	...	...	...	30.0	...	...	...	...	...	...		0.3	0.6	0.9
5 54.3	...	...	...	25.2	...	...	...	...	...	...	...		0.3	0.6	0.9
54.7	...	...	21.1	...	...	...	...	...	...	...	...		0.3	0.6	0.9
55.0	...	17.4	...	...	...	...	...	...	...	...	...		0.3	0.5	0.8
5 55.2	14.2	...	...	...	...	...	...	...	...	...	...	1	0.3	0.5	0.8

See footnote pages 18 and 19 for equation to be employed when values in seconds are required.

Mean Time Hour Angle	AZIMUTH OF POLARIS AT ALL HOUR ANGLES, 1986												CORR. TO AZIMUTH		
	Mean Declination + 89° 12' 20"												Add for Decl. + 89°		
													12'10"	12'00"	11'50"
	Latitude												Subtract for Decl. + 89°		
	50°	52°	54°	56°	58°	60°	61°	62°	63°	64°	65°	Az.	12'30"	12'40"	12'50"
h m	/	/	/	/	/	/	/	/	/	/	/	°	/	/	/
5 52.2	...	...	...	...	...	...	...	...	...	...	52.8	1	0.4	0.8	1.2
52.5	...	...	...	...	...	...	...	...	...	48.8	...	...	0.4	0.8	1.1
52.8	...	...	...	...	...	...	...	...	45.0	...	...	...	0.4	0.7	1.1
5 53.1	...	...	...	...	...	...	...	41.5	...	...	...	...	0.4	0.7	1.1
53.3	...	...	...	...	...	...	38.3	...	...	...	...	...	0.3	0.7	1.0
53.5	...	...	...	...	...	35.3	...	...	...	...	...	...	0.3	0.7	1.0
5 53.9	...	...	...	...	30.0	...	...	...	...	...	...	...	0.3	0.6	0.9
54.3	...	...	...	25.2	...	...	...	...	...	...	...	...	0.3	0.6	0.9
54.7	...	...	21.1	...	...	...	...	...	...	...	...	...	0.3	0.6	0.9
5 55.0	...	17.4	...	...	...	...	...	...	...	...	...	...	0.3	0.5	0.8
55.2	14.2	...	...	...	...	...	...	...	...	...	...	...	0.3	0.5	0.8
59.0	14.1	17.4	21.1	25.2	29.9	35.3	38.3	41.5	45.0	48.7	52.8	...	0.3	0.6	0.9
6 09.0	14.0	17.3	20.9	25.1	29.8	35.1	38.1	41.3	44.7	48.5	52.5	...	0.3	0.6	0.9
19.0	13.8	17.0	20.6	24.8	29.4	34.8	37.7	40.9	44.3	48.0	52.0	...	0.3	0.6	0.9
28.9	13.4	16.6	20.2	24.3	28.9	34.2	37.1	40.3	43.7	47.4	51.4	...	0.3	0.6	0.9
6 38.9	12.8	16.0	19.6	23.6	28.2	33.5	36.4	39.5	42.9	46.5	50.5	...	0.3	0.6	0.9
48.9	12.1	15.3	18.8	22.8	27.4	32.6	35.5	38.5	41.9	45.5	49.4	...	0.3	0.6	0.9
58.9	11.3	14.4	17.9	21.9	26.4	31.5	34.3	37.4	40.7	44.2	48.1	...	0.3	0.6	0.9
7 08.8	10.4	13.4	16.9	20.8	25.2	30.3	33.1	36.1	39.3	42.8	46.6	...	0.3	0.6	0.9
18.8	9.3	12.3	15.7	19.5	23.9	28.8	31.6	34.5	37.7	41.2	44.9	...	0.3	0.6	0.9
28.8	8.1	11.0	14.4	18.1	22.4	27.3	30.0	32.9	36.0	39.4	43.0	...	0.3	0.6	0.9
7 38.7	6.7	9.6	12.9	16.6	20.8	25.5	28.2	31.0	34.1	37.4	40.9	...	0.3	0.6	0.8
48.7	5.3	8.1	11.3	14.9	19.0	23.6	26.2	29.0	32.0	35.2	38.7	...	0.3	0.6	0.8
58.7	3.7	6.5	9.6	13.1	17.0	21.6	24.1	26.8	29.7	32.8	36.2	...	0.3	0.5	0.8
8 08.7	2.0	4.7	7.7	11.1	15.0	19.4	21.8	24.4	27.3	30.3	33.6	...	0.3	0.5	0.8
18.6	0.2	2.8	5.7	9.0	12.8	17.0	19.4	21.9	24.7	27.6	30.8	...	0.3	0.5	0.8
28.6	58.2	0.8	3.6	6.8	10.4	14.5	16.8	19.3	21.9	24.8	27.9	...	0.2	0.5	0.7
8 38.6	56.2	58.6	1.4	4.4	7.9	11.9	14.1	16.5	19.0	21.8	24.8	...	0.2	0.5	0.7
48.6	54.1	56.4	59.0	2.0	5.3	9.2	11.3	13.6	16.0	18.6	21.5	...	0.2	0.5	0.7
58.5	51.8	54.1	56.6	59.4	2.6	6.3	8.3	10.5	12.8	15.4	18.1	...	0.2	0.4	0.7
9 08.5	49.5	51.6	54.0	56.7	59.8	3.3	5.2	7.3	9.5	11.9	14.6	...	0.2	0.4	0.6
18.5	47.1	49.1	51.4	53.9	56.9	0.2	2.0	4.0	6.1	8.4	10.9	...	0.2	0.4	0.6
28.4	44.6	46.5	48.6	51.1	53.8	56.9	58.7	0.6	2.6	4.7	7.1	...	0.2	0.4	0.6
9 38.4	42.0	43.8	45.8	48.1	50.7	53.6	55.3	57.0	58.9	0.9	3.2	1	0.2	0.4	0.5
48.4	39.3	41.0	42.9	45.0	47.4	50.2	51.7	53.4	55.1	57.1	59.1	0	0.2	0.3	0.5
58.4	36.6	38.1	39.9	41.9	44.1	46.7	48.1	49.6	51.3	53.1	55.0	...	0.2	0.3	0.5
10 08.3	33.7	35.2	36.8	38.7	40.7	43.1	44.4	45.8	47.3	49.0	50.7	...	0.1	0.3	0.4
18.3	30.9	32.2	33.7	35.4	37.3	39.4	40.6	41.9	43.3	44.8	46.4	...	0.1	0.3	0.4
28.3	28.0	29.2	30.5	32.0	33.7	35.7	36.8	37.9	39.2	40.5	42.0	...	0.1	0.2	0.4
10 38.3	25.0	26.0	27.2	28.6	30.1	31.9	32.9	33.9	35.0	36.2	37.5	...	0.1	0.2	0.3
48.2	22.0	22.9	24.0	25.1	26.5	28.0	28.9	29.8	30.8	31.8	33.0	...	0.1	0.2	0.3
58.2	18.9	19.7	20.6	21.6	22.8	24.1	24.8	25.6	26.5	27.4	28.4	...	0.1	0.2	0.2
11 08.2	15.8	16.5	17.2	18.1	19.1	20.2	20.8	21.4	22.1	22.9	23.7	...	0.1	0.1	0.2
18.1	12.7	13.2	13.8	14.5	15.3	16.2	16.7	17.2	17.8	18.4	19.0	...	0.1	0.1	0.2
28.1	9.5	9.9	10.4	10.9	11.5	12.2	12.5	12.9	13.3	13.8	14.3	...	0.0	0.1	0.1
11 38.1	6.4	6.6	6.9	7.3	7.7	8.1	8.4	8.6	8.9	9.2	9.5	...	0.0	0.1	0.1
48.1	3.2	3.3	3.5	3.6	3.8	4.1	4.2	4.3	4.5	4.6	4.8	...	0.0	0.0	0.0
58.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0

See footnote pages 18 and 19 for equation to be employed when values in seconds are required.

Lat.	Correction to the Time of Elongation	AZIMUTH OF POLARIS AT ELONGATION, 1986							
		Decl. +89°							
		11' 50"	12' 00"	12' 10"	12' 20"	12' 30"	12' 40"	12' 50"	
° ' "	W.E. m E.E.	° ' "	° ' "	° ' "	° ' "	° ' "	° ' "	° ' "	° ' "
10 00	+2.1-	0 48 55	0 48 44	0 48 34	0 48 24	0 48 14	0 48 04	0 47 54	
12 00	2.0	0 49 15	0 49 04	0 48 54	0 48 44	0 48 34	0 48 23	0 48 13	
14 00	1.9	0 49 38	0 49 28	0 49 18	0 49 08	0 48 57	0 48 47	0 48 37	
16 00	1.8	0 50 06	0 49 56	0 49 46	0 49 35	0 49 25	0 49 14	0 49 04	
18 00	1.6	0 50 39	0 50 28	0 50 18	0 50 07	0 49 57	0 49 46	0 49 36	
20 00	1.5	0 51 15	0 51 05	0 50 54	0 50 44	0 50 33	0 50 22	0 50 12	
21 00	1.5	0 51 36	0 51 25	0 51 14	0 51 03	0 50 53	0 50 42	0 50 31	
22 00	1.4	0 51 57	0 51 46	0 51 35	0 51 25	0 51 14	0 51 03	0 50 52	
23 00	1.3	0 52 20	0 52 09	0 51 58	0 51 47	0 51 36	0 51 25	0 51 14	
24 00	1.3	0 52 44	0 52 33	0 52 22	0 52 11	0 52 00	0 51 49	0 51 38	
25 00	1.2	0 53 09	0 52 58	0 52 47	0 52 36	0 52 25	0 52 14	0 52 03	
26 00	1.1	0 53 35	0 53 24	0 53 13	0 53 02	0 52 51	0 52 40	0 52 29	
27 00	1.1	0 54 04	0 53 52	0 53 41	0 53 30	0 53 19	0 53 07	0 52 56	
28 00	1.0	0 54 33	0 54 22	0 54 11	0 53 59	0 53 48	0 53 37	0 53 25	
29 00	0.9	0 55 04	0 54 53	0 54 41	0 54 30	0 54 19	0 54 07	0 53 56	
30 00	0.8	0 55 37	0 55 26	0 55 14	0 55 02	0 54 51	0 54 39	0 54 28	
31 00	0.8	0 56 12	0 56 00	0 55 48	0 55 37	0 55 25	0 55 13	0 55 02	
32 00	0.7	0 56 48	0 56 36	0 56 24	0 56 12	0 56 01	0 55 49	0 55 37	
33 00	0.6	0 57 26	0 57 14	0 57 02	0 56 50	0 56 38	0 56 26	0 56 14	
34 00	0.5	0 58 06	0 57 54	0 57 42	0 57 30	0 57 18	0 57 06	0 56 54	
35 00	0.4	0 58 48	0 58 36	0 58 24	0 58 11	0 57 59	0 57 47	0 57 35	
36 00	0.4	0 59 32	0 59 20	0 59 08	0 58 55	0 58 43	0 58 30	0 58 18	
37 00	0.3	1 00 19	1 00 06	0 59 54	0 59 41	0 59 29	0 59 16	0 59 04	
38 00	0.2	1 01 08	1 00 55	1 00 42	1 00 29	1 00 17	1 00 04	0 59 51	
39 00	+0.1-	1 01 59	1 01 46	1 01 33	1 01 20	1 01 07	1 00 54	1 00 42	
40 00	0.0	1 02 53	1 02 40	1 02 27	1 02 14	1 02 00	1 01 47	1 01 34	
41 00	-0.1+	1 03 49	1 03 36	1 03 23	1 03 10	1 02 56	1 02 43	1 02 30	
42 00	0.2	1 04 49	1 04 36	1 04 22	1 04 09	1 03 55	1 03 42	1 03 28	
43 00	0.3	1 05 52	1 05 38	1 05 24	1 05 11	1 04 57	1 04 43	1 04 30	
44 00	0.4	1 06 58	1 06 44	1 06 30	1 06 16	1 06 02	1 05 48	1 05 34	
45 00	0.5	1 08 07	1 07 53	1 07 39	1 07 25	1 07 11	1 06 56	1 06 42	
46 00	0.6	1 09 20	1 09 06	1 08 52	1 08 37	1 08 23	1 08 08	1 07 54	
47 00	0.7	1 10 38	1 10 23	1 10 08	1 09 54	1 09 39	1 09 24	1 09 10	
48 00	0.9	1 11 59	1 11 44	1 11 29	1 11 14	1 10 59	1 10 44	1 10 30	
49 00	1.0	1 13 25	1 13 10	1 12 55	1 12 40	1 12 24	1 12 09	1 11 54	
50 00	1.1	1 14 56	1 14 41	1 14 25	1 14 10	1 13 54	1 13 38	1 13 23	
51 00	1.3	1 16 32	1 16 17	1 16 01	1 15 45	1 15 29	1 15 13	1 14 57	
52 00	1.4	1 18 14	1 17 58	1 17 42	1 17 26	1 17 09	1 16 53	1 16 37	
53 00	1.6	1 20 02	1 19 46	1 19 29	1 19 13	1 18 56	1 18 39	1 18 23	
54 00	1.7	1 21 57	1 21 40	1 21 23	1 21 06	1 20 49	1 20 32	1 20 15	
55 00	1.9	1 23 59	1 23 41	1 23 24	1 23 07	1 22 49	1 22 32	1 22 14	
55 30	2.0	1 25 03	1 24 45	1 24 27	1 24 10	1 23 52	1 23 34	1 23 17	
56 00	2.1	1 26 09	1 25 51	1 25 33	1 25 15	1 24 57	1 24 39	1 24 21	
56 30	2.1	1 27 16	1 26 58	1 26 40	1 26 22	1 26 04	1 25 46	1 25 28	
57 00	2.2	1 28 27	1 28 08	1 27 50	1 27 32	1 27 13	1 26 55	1 26 36	
57 30	2.3	1 29 39	1 29 21	1 29 02	1 28 43	1 28 25	1 28 06	1 27 47	
58 00	2.4	1 30 54	1 30 35	1 30 16	1 29 57	1 29 39	1 29 20	1 29 01	
58 30	2.5	1 32 12	1 31 52	1 31 33	1 31 14	1 30 55	1 30 36	1 30 17	
59 00	2.6	1 33 32	1 33 12	1 32 53	1 32 33	1 32 14	1 31 55	1 31 35	
59 30	2.7	1 34 55	1 34 35	1 34 15	1 33 56	1 33 36	1 33 16	1 32 56	
60 00	2.8	1 36 21	1 36 01	1 35 41	1 35 21	1 35 01	1 34 41	1 34 21	
60 30	3.0	1 37 50	1 37 29	1 37 09	1 36 49	1 36 28	1 36 08	1 35 48	
61 00	3.1	1 39 22	1 39 01	1 38 40	1 38 20	1 37 59	1 37 39	1 37 18	
61 30	3.2	1 40 57	1 40 36	1 40 15	1 39 54	1 39 33	1 39 13	1 38 52	
62 00	3.3	1 42 37	1 42 15	1 41 54	1 41 33	1 41 11	1 40 50	1 40 29	
62 30	3.4	1 44 20	1 43 58	1 43 36	1 43 15	1 42 53	1 42 31	1 42 10	
63 00	3.6	1 46 07	1 45 45	1 45 23	1 45 00	1 44 38	1 44 16	1 43 54	
63 30	3.7	1 47 58	1 47 35	1 47 13	1 46 51	1 46 28	1 46 06	1 45 43	
64 00	3.9	1 49 53	1 49 31	1 49 08	1 48 45	1 48 22	1 47 59	1 47 37	
64 30	4.0	1 51 54	1 51 31	1 51 07	1 50 44	1 50 21	1 49 58	1 49 34	
65 00	4.2	1 53 59	1 53 36	1 53 12	1 52 48	1 52 25	1 52 01	1 51 37	
65 30	4.3	1 56 10	1 55 46	1 55 22	1 54 58	1 54 34	1 54 09	1 53 45	
66 00	4.5	1 58 27	1 58 02	1 57 37	1 57 13	1 56 48	1 56 24	1 55 59	
66 30	4.7	2 00 49	2 00 24	1 59 59	1 59 34	1 59 09	1 58 43	1 58 18	
67 00	4.8	2 03 18	2 02 52	2 02 27	2 02 01	2 01 35	2 01 10	2 00 44	
67 30	5.0	2 05 53	2 05 27	2 05 01	2 04 35	2 04 09	2 03 43	2 03 16	
68 00	5.2	2 08 36	2 08 10	2 07 43	2 07 16	2 06 49	2 06 23	2 05 56	
68 30	5.4	2 11 27	2 11 00	2 10 32	2 10 05	2 09 38	2 09 11	2 08 43	
69 00	5.6	2 14 26	2 13 58	2 13 30	2 13 02	2 12 34	2 12 07	2 11 39	
69 30	5.9	2 17 34	2 17 06	2 16 37	2 16 08	2 15 40	2 15 11	2 14 43	
70 00	-6.1+	2 20 52	2 20 23	2 19 53	2 19 24	2 18 55	2 18 26	2 17 56	

TO FIND THE LATITUDE BY AN ALTITUDE OBSERVATION OF POLARIS AT ANY HOUR ANGLE, 1986														
Mean Time Hour Angle	Primary Adjustment to Elevation of Pole													Mean Time Hour Angle
	Subtract Polaris Above the Pole					Add Polaris Below the Pole								
	Decl. +89°					Decl. +89°								
	11' 50"	12' 10"	12' 30"	12' 50"	11' 50"	12' 10"	12' 30"	12' 50"	11' 50"	12' 10"	12' 30"	12' 50"		
^h ^m 0 00.0	[°] ['] ["] 0 48 10	[°] ['] ["] 0 47 50	[°] ['] ["] 0 47 30	[°] ['] ["] 0 47 10	[°] ['] ["] 0 00 00 0 00 20	[°] ['] ["] 0 00 00 0 00 20	[°] ['] ["] 0 00 00 0 00 20	[°] ['] ["] 0 00 00 0 00 19	^h ^m 5 57.4 5 59.0					
0 12.0	0 48 06	0 47 46	0 47 26	0 47 06	0 01 36	0 01 35	0 01 34	0 01 33	6 05.0					
23.9	47 54	47 34	47 14	46 54	02 51	02 50	02 49	02 47	11.0					
35.9	47 34	47 14	46 54	46 35	04 07	04 05	04 03	04 01	17.0					
47.9	47 06	46 46	46 27	46 07	05 22	05 20	05 17	05 15	23.0					
59.8	46 30	46 11	45 52	45 32	06 37	06 34	06 31	06 28	28.9					
1 11.8	0 45 47	0 45 28	0 45 09	0 44 50	0 07 52	0 07 48	0 07 45	0 07 42	6 34.9					
23.8	44 55	44 37	44 18	44 00	09 06	09 02	08 58	08 55	40.9					
35.7	43 57	43 39	43 20	43 02	10 20	10 16	10 11	10 07	46.9					
47.7	42 51	42 33	42 15	41 58	11 34	11 29	11 24	11 19	52.9					
59.7	41 38	41 21	41 03	40 46	12 47	12 41	12 36	12 31	58.9					
2 11.6	0 40 18	0 40 01	0 39 44	0 39 28	0 13 59	0 13 54	0 13 48	0 13 42	7 04.8					
23.6	38 51	38 35	38 19	38 03	15 11	15 05	14 59	14 52	10.8					
35.6	37 18	37 03	36 47	36 32	16 23	16 16	16 09	16 02	16.8					
47.5	35 39	35 24	35 09	34 54	17 33	17 26	17 19	17 11	22.8					
59.5	33 53	33 39	33 25	33 11	18 43	18 35	18 28	18 20	28.8					
3 05.5	0 32 59	0 32 45	0 32 32	0 32 18	0 19 52	0 19 44	0 19 36	0 19 27	7 34.8					
11.5	32 03	31 49	31 36	31 23	21 01	20 52	20 43	20 34	40.7					
17.5	31 05	30 52	30 40	30 27	22 08	21 59	21 50	21 40	46.7					
23.4	30 07	29 54	29 42	29 29	23 15	23 05	22 55	22 45	52.7					
29.4	29 07	28 55	28 43	28 31	24 20	24 10	24 00	23 50	58.7					
3 35.4	0 28 06	0 27 54	0 27 42	0 27 31	0 25 25	0 25 14	0 25 04	0 24 53	8 04.7					
41.4	27 03	26 52	26 41	26 30	26 28	26 17	26 06	25 55	10.7					
47.4	26 00	25 49	25 38	25 28	27 31	27 19	27 08	26 56	16.6					
53.4	24 55	24 45	24 35	24 25	28 32	28 20	28 08	27 56	22.6					
59.3	23 50	23 40	23 30	23 21	29 32	29 20	29 07	28 55	28.6					
4 05.3	0 22 43	0 22 34	0 22 25	0 22 15	0 30 31	0 30 18	0 30 06	0 29 53	8 34.6					
11.3	21 36	21 27	21 18	21 09	31 29	31 16	31 02	30 49	40.6					
17.3	20 28	20 19	20 11	20 03	32 25	32 12	31 58	31 44	46.6					
23.3	19 19	19 11	19 03	18 55	33 20	33 06	32 52	32 38	52.5					
29.3	18 09	18 01	17 54	17 46	34 14	33 59	33 45	33 31	58.5					
4 35.2	0 16 58	0 16 51	0 16 44	0 16 37	0 35 57	0 35 42	0 35 27	0 35 12	9 10.5					
41.2	15 47	15 40	15 34	15 27	37 34	37 18	37 03	36 47	22.5					
47.2	14 35	14 29	14 23	14 17	39 05	38 49	38 33	38 16	34.4					
53.2	13 22	13 17	13 11	13 06	40 30	40 13	39 56	39 39	46.4					
59.2	12 09	12 04	11 59	11 54	41 48	41 31	41 13	40 56	58.4					
5 05.2	0 10 56	0 10 51	0 10 47	0 10 42	0 42 59	0 42 41	0 42 23	0 42 06	10 10.3					
11.1	09 42	09 38	09 34	09 30	44 04	43 45	43 27	43 09	22.3					
17.1	08 27	08 24	08 20	08 17	45 01	44 42	44 23	44 05	34.3					
23.1	07 12	07 10	07 07	07 04	45 51	45 31	45 12	44 53	46.2					
29.1	05 57	05 55	05 53	05 50	46 33	46 14	45 54	45 35	58.2					
5 35.1	0 04 42	0 04 40	0 04 38	0 04 37	0 47 08	0 46 48	0 46 29	0 46 09	11 10.2					
41.1	03 27	03 25	03 24	03 23	47 35	47 15	46 55	46 36	22.1					
47.0	02 11	02 10	02 10	02 09	47 54	47 34	47 15	46 55	34.1					
53.0	00 55	00 55	00 55	00 55	48 06	47 46	47 26	47 06	46.1					
57.4	00 00	00 00	00 00	00 00	48 10	47 50	47 30	47 10	58.0					
Mean Time Hour Angle	Supplemental Correction to be Applied to the Vertical Angle Reading													Mean Time Hour Angle
	Altitude													
	10°	15°	20°	25°	30°	35°	40°	45°	50°	55°	60°	65°	70°	
^h ^m 0 00	["] 0	["] 0	["] 0	["] 0	["] 0	["] 0	["] 0	["] 0	["] 0	["] 0	["] 0	["] 0	["] 0	^h ^m 11 58
1 00	- 1	- 1	- 1	- 1	- 1	- 0	- 0	0	+ 0	+ 1	+ 1	+ 2	+ 2	10 58
2 00	4	4	3	3	2	- 1	- 1	0	1	2	4	6	9	9 58
3 00	8	7	6	5	4	3	2	0	2	4	7	11	17	8 58
3 59	12	11	9	8	6	4	2	0	3	6	11	17	26	7 59
4 59	15	14	12	10	8	6	3	0	4	8	14	21	32	6 59
5 59	-16	-15	-13	-11	- 8	- 6	- 3	0	+ 4	+ 8	+15	+23	+35	5 59

EXPLANATIONS FOR THE STELLAR OBSERVATIONS

The data in this Ephemeris are arranged for the surveying practice of the Bureau of Land Management; the methods are useful in any survey where field observations are to be made for the ascertainment of the direction of a line in terms of angular value referred to the true meridian at that place.

In most cases, data are available as to the approximate latitude and longitude of the observing station, and preliminary determinations are made for the meridian and watch correction in terms of local mean time. The observations of the stars then follow on an observing program arranged for what is needed, and to suit the time of year, the latitude of the station, and other conditions that are factors.

A complete and well balanced stellar observing program will include: (1) the meridian passage of one star for time and latitude; (2) Polaris for azimuth and latitude; and (3) two well placed stars, one easterly and one westerly, both for azimuth, and one or both for time. The necessary verifications are thus accomplished. Instrumental uncertainties in the vertical angle readings are made apparent by this plan, and are compensated by taking the means of offsetting values. An observation may be made to verify only one or two values when the remainder are already well determined.

There are six stellar observing periods: (1) late afternoon, daylight; (2) early evening, twilight; (3) later p. m., after dark, illumination required; (4) after midnight, ditto; (5) early morning, twilight; and (6) after sunrise, daylight. The stars to be observed are chosen after deciding upon the observing period, and making the selection according to the desired position in hour angle and declination.

The time of a star's transit is to be reduced from the tabulated value for the Greenwich meridian to the longitude of the station; this is 10 seconds of time for each 15° (or one hour) of longitude, subtracted for west longitude (see table of Sidereal Conversions, page 27); this will give the correct local mean time at the moment of the star's meridian passage. The next step is to anticipate the probable local mean time of each observation, and the star's hour angle at that moment, to the east or to the west of the meridian.

The setting positions for the instrument in vertical angle (v) and in horizontal angle (A) are computed on the basis of the assumed hour angle (t), the star's declination (δ), and the known or approximate latitude (ϕ). This is done to secure a setting that is sufficiently accurate to bring the star within the field of the telescope, especially if the observation is to be by daylight, or twilight; less accuracy is needed just for the star's identification if the observation is to be made during starlight. The preliminary computations may be made with 4-place tables. The true values are obtained by reduction of the observations. The reductions for stellar observations are similar to the methods applicable to observations of the sun, and employ the same equations.

In all stellar observations, the true vertical angle (h) is equal to the observed vertical angle (v) minus the refraction (r) in zenith distance; there is no correction for parallax. In observations of the sun, the true vertical angle (h) is equal to (v) minus (r) plus parallax; see table, page 25.

In observations of the sun, the meridian passage and the hour angle (t) are in apparent solar time. The equation of time is applied to give the watch correction in terms of local mean time.

In observations of a star, the hour angle (t) is in terms of a sidereal rate; a subtraction of 10 seconds per hour will give the equivalent mean time hour angle. (Sidereal Conversions, page 27).

The following equations are regarded as the most useful for the methods stated above:

On the meridian, the vertical angle: $h = 90^\circ - \phi \pm \delta$; (or) $\phi = 90^\circ - h \pm \delta$

At any hour angle: $\sin h = \cos t \cos \phi \cos \delta + \sin \phi \sin \delta$

$$: \cos t = \frac{\sin h}{\cos \phi \cos \delta} - \tan \phi \tan \delta$$

$$: \cos A = \frac{\sin \delta}{\cos \phi \cos h} - \tan \phi \tan h$$

The product " $\sin \phi \sin \delta$ " and the fraction " $\frac{\sin \delta}{\cos \phi \cos h}$ " are negative for south declinations.

The product " $\cos t \cos \phi \cos \delta$ " is negative for hour angles exceeding six hours or 90°.

The product " $\tan \phi \tan \delta$ " is subtracted for north declinations; added for south declinations.

If the result for " $\cos A$ " is $\begin{cases} \text{positive} \\ \text{negative} \end{cases}$ the horizontal angle counts from the $\begin{cases} \text{north.} \\ \text{south.} \end{cases}$

If the result for " $\cos t$ " is $\begin{cases} \text{positive} \\ \text{negative} \end{cases}$ the hour angle is $\begin{cases} \text{less} \\ \text{more} \end{cases}$ than six hours or 90°.

By a stellar equal-altitude observation, the meridian is determined as the mean of two direction-pointings; the latitude is not required; there are no corrections as to declination. A mean of the watch readings at the moment of each observation is equivalent to a reading at the time of the star's meridian passage. The latitude may be reduced from the maximum vertical angle at meridian passage.

The equations as written and explained above are applicable for the northern latitudes; suitable transpositions are required for observations in the southern latitudes.

MEAN REFRACTIONS IN ZENITH DISTANCE AND SUN'S PARALLAX IN ALTITUDE
Bar. : 29.6 ins. Temp. : 50° F.

Apparent Altitude	Refraction	Sun's Par.	Apparent Altitude	Refraction	Sun's Par.	Apparent Altitude	Refraction	Sun's Par.
° ' "	' "	"	° ' "	' "	"	°	' "	"
7 30	6 53	8.8	12 0	4 25	8.7	25	2 3	8.1
7 40	6 45	8.8	12 30	4 15	8.7	26	1 58	8.0
7 50	6 37	8.8	13 0	4 5	8.7	27	1 53	7.9
8 0	6 30	8.8	13 30	3 56	8.7	28	1 48	7.9
8 10	6 22	8.8	14 0	3 47	8.6	29	1 44	7.8
8 20	6 15	8.8	14 30	3 39	8.6	30	1 40	7.7
8 30	6 8	8.8	15 0	3 32	8.6	32	1 32	7.6
8 40	6 2	8.8	15 30	3 25	8.6	34	1 25	7.4
8 50	5 55	8.8	16 0	3 19	8.6	36	1 19	7.2
9 0	5 49	8.8	16 30	3 13	8.5	38	1 14	7.0
9 10	5 43	8.8	17 0	3 7	8.5	40	1 9	6.8
9 20	5 38	8.8	17 30	3 1	8.5	42	1 4	6.6
9 30	5 32	8.8	18 0	2 56	8.5	44	1 0	6.4
9 40	5 26	8.8	18 30	2 51	8.4	46	0 56	6.2
9 50	5 21	8.8	19 0	2 46	8.4	48	0 52	6.0
10 0	5 16	8.8	19 30	2 42	8.4	50	0 48	5.7
10 20	5 6	8.8	20 0	2 37	8.4	55	0 40	5.1
10 40	4 57	8.7	21 0	2 29	8.3	60	0 33	4.4
11 0	4 48	8.7	22 0	2 22	8.2	65	0 27	3.8
11 20	4 40	8.7	23 0	2 15	8.2	70	0 21	3.0
11 40	4 32	8.7	24 0	2 9	8.1	80	0 10	1.5
12 0	4 25	8.7	25 0	2 3	8.1	90	0 0	0.0
Apparent altitude (observed vertical angle) : v Sun's true altitude : h = v - refraction + parallax Star's true altitude : h = v - refraction					True refraction : mean refraction x coefficient for barometric pressure x coefficient for temperature.			

COEFFICIENTS TO APPLY TO MEAN REFRACTIONS FOR VARIATIONS IN BAROMETER AND TEMPERATURE

Barome- ter (Ins.)	Eleva- tion above sea level (Feet)	Coeffi- cient	Barome- ter (Ins.)	Eleva- tion above sea level (Feet)	Coeffi- cient	Barome- ter (Ins.)	Eleva- tion above sea level (Feet)	Coeffi- cient	Temper- ature (Fahr.)	Coeffi- cient
30.5	-451	1.03	27.2	2,670	0.92	23.6	6,538	0.80	-10°	1.13
30.2	-181	1.02	26.9	2,972	.91	23.3	6,887	.79	0°	1.11
30.0	00	1.01	26.6	3,277	.90	23.0	7,239	.78	+10°	1.08
29.9	+ 91	1.01	26.3	3,586	.89	22.7	7,597	.77	20°	1.06
29.6	366	1.00	26.0	3,899	.88	22.4	7,960	.76	30°	1.04
29.3	643	.99	25.7	4,215	.87	22.1	8,327	.75	40°	1.02
29.0	924	.98	25.4	4,535	.86	21.8	8,700	.74	50°	1.00
28.7	1,207	.97	25.1	4,859	.85	21.5	9,077	.73	60°	.98
28.4	1,493	.96	24.8	5,186	.84	21.2	9,460	.72	70°	.96
28.1	1,783	.95	24.5	5,518	.83	20.9	9,848	.71	80°	.94
27.8	2,075	.94	24.2	5,854	.82	20.6	10,242	.70	90°	.93
27.5	2,371	.93	23.9	6,194	.81	20.3	10,642	.69	100°	.91
27.2	2,670	.92	23.6	6,538	.80	20.0	11,047	.68	+110°	.90

26
CONVERSION OF TIME TO ARC

Min- utes	Hours												
	0	1	2	3	4	5	6	7	8	9	10	11	12
	° '	° '	° '	° '	° '	° '	° '	° '	° '	° '	° '	° '	° '
0	0 00	15 00	30 00	45 00	60 00	75 00	90 00	105 00	120 00	135 00	150 00	165 00	180 00
1	0 15	15 15	30 15	45 15	60 15	75 15	90 15	105 15	120 15	135 15	150 15	165 15	180 15
2	0 30	15 30	30 30	45 30	60 30	75 30	90 30	105 30	120 30	135 30	150 30	165 30	180 30
3	0 45	15 45	30 45	45 45	60 45	75 45	90 45	105 45	120 45	135 45	150 45	165 45	180 45
4	1 00	16 00	31 00	46 00	61 00	76 00	91 00	106 00	121 00	136 00	151 00	166 00	181 00
5	1 15	16 15	31 15	46 15	61 15	76 15	91 15	106 15	121 15	136 15	151 15	166 15	181 15
6	1 30	16 30	31 30	46 30	61 30	76 30	91 30	106 30	121 30	136 30	151 30	166 30	181 30
7	1 45	16 45	31 45	46 45	61 45	76 45	91 45	106 45	121 45	136 45	151 45	166 45	181 45
8	2 00	17 00	32 00	47 00	62 00	77 00	92 00	107 00	122 00	137 00	152 00	167 00	182 00
9	2 15	17 15	32 15	47 15	62 15	77 15	92 15	107 15	122 15	137 15	152 15	167 15	182 15
10	2 30	17 30	32 30	47 30	62 30	77 30	92 30	107 30	122 30	137 30	152 30	167 30	182 30
11	2 45	17 45	32 45	47 45	62 45	77 45	92 45	107 45	122 45	137 45	152 45	167 45	182 45
12	3 00	18 00	33 00	48 00	63 00	78 00	93 00	108 00	123 00	138 00	153 00	168 00	183 00
13	3 15	18 15	33 15	48 15	63 15	78 15	93 15	108 15	123 15	138 15	153 15	168 15	183 15
14	3 30	18 30	33 30	48 30	63 30	78 30	93 30	108 30	123 30	138 30	153 30	168 30	183 30
15	3 45	18 45	33 45	48 45	63 45	78 45	93 45	108 45	123 45	138 45	153 45	168 45	183 45
16	4 00	19 00	34 00	49 00	64 00	79 00	94 00	109 00	124 00	139 00	154 00	169 00	184 00
17	4 15	19 15	34 15	49 15	64 15	79 15	94 15	109 15	124 15	139 15	154 15	169 15	184 15
18	4 30	19 30	34 30	49 30	64 30	79 30	94 30	109 30	124 30	139 30	154 30	169 30	184 30
19	4 45	19 45	34 45	49 45	64 45	79 45	94 45	109 45	124 45	139 45	154 45	169 45	184 45
20	5 00	20 00	35 00	50 00	65 00	80 00	95 00	110 00	125 00	140 00	155 00	170 00	185 00
21	5 15	20 15	35 15	50 15	65 15	80 15	95 15	110 15	125 15	140 15	155 15	170 15	185 15
22	5 30	20 30	35 30	50 30	65 30	80 30	95 30	110 30	125 30	140 30	155 30	170 30	185 30
23	5 45	20 45	35 45	50 45	65 45	80 45	95 45	110 45	125 45	140 45	155 45	170 45	185 45
24	6 00	21 00	36 00	51 00	66 00	81 00	96 00	111 00	126 00	141 00	156 00	171 00	186 00
25	6 15	21 15	36 15	51 15	66 15	81 15	96 15	111 15	126 15	141 15	156 15	171 15	186 15
26	6 30	21 30	36 30	51 30	66 30	81 30	96 30	111 30	126 30	141 30	156 30	171 30	186 30
27	6 45	21 45	36 45	51 45	66 45	81 45	96 45	111 45	126 45	141 45	156 45	171 45	186 45
28	7 00	22 00	37 00	52 00	67 00	82 00	97 00	112 00	127 00	142 00	157 00	172 00	187 00
29	7 15	22 15	37 15	52 15	67 15	82 15	97 15	112 15	127 15	142 15	157 15	172 15	187 15
30	7 30	22 30	37 30	52 30	67 30	82 30	97 30	112 30	127 30	142 30	157 30	172 30	187 30
31	7 45	22 45	37 45	52 45	67 45	82 45	97 45	112 45	127 45	142 45	157 45	172 45	187 45
32	8 00	23 00	38 00	53 00	68 00	83 00	98 00	113 00	128 00	143 00	158 00	173 00	188 00
33	8 15	23 15	38 15	53 15	68 15	83 15	98 15	113 15	128 15	143 15	158 15	173 15	188 15
34	8 30	23 30	38 30	53 30	68 30	83 30	98 30	113 30	128 30	143 30	158 30	173 30	188 30
35	8 45	23 45	38 45	53 45	68 45	83 45	98 45	113 45	128 45	143 45	158 45	173 45	188 45
36	9 00	24 00	39 00	54 00	69 00	84 00	99 00	114 00	129 00	144 00	159 00	174 00	189 00
37	9 15	24 15	39 15	54 15	69 15	84 15	99 15	114 15	129 15	144 15	159 15	174 15	189 15
38	9 30	24 30	39 30	54 30	69 30	84 30	99 30	114 30	129 30	144 30	159 30	174 30	189 30
39	9 45	24 45	39 45	54 45	69 45	84 45	99 45	114 45	129 45	144 45	159 45	174 45	189 45
40	10 00	25 00	40 00	55 00	70 00	85 00	100 00	115 00	130 00	145 00	160 00	175 00	190 00
41	10 15	25 15	40 15	55 15	70 15	85 15	100 15	115 15	130 15	145 15	160 15	175 15	190 15
42	10 30	25 30	40 30	55 30	70 30	85 30	100 30	115 30	130 30	145 30	160 30	175 30	190 30
43	10 45	25 45	40 45	55 45	70 45	85 45	100 45	115 45	130 45	145 45	160 45	175 45	190 45
44	11 00	26 00	41 00	56 00	71 00	86 00	101 00	116 00	131 00	146 00	161 00	176 00	191 00
45	11 15	26 15	41 15	56 15	71 15	86 15	101 15	116 15	131 15	146 15	161 15	176 15	191 15
46	11 30	26 30	41 30	56 30	71 30	86 30	101 30	116 30	131 30	146 30	161 30	176 30	191 30
47	11 45	26 45	41 45	56 45	71 45	86 45	101 45	116 45	131 45	146 45	161 45	176 45	191 45
48	12 00	27 00	42 00	57 00	72 00	87 00	102 00	117 00	132 00	147 00	162 00	177 00	192 00
49	12 15	27 15	42 15	57 15	72 15	87 15	102 15	117 15	132 15	147 15	162 15	177 15	192 15
50	12 30	27 30	42 30	57 30	72 30	87 30	102 30	117 30	132 30	147 30	162 30	177 30	192 30
51	12 45	27 45	42 45	57 45	72 45	87 45	102 45	117 45	132 45	147 45	162 45	177 45	192 45
52	13 00	28 00	43 00	58 00	73 00	88 00	103 00	118 00	133 00	148 00	163 00	178 00	193 00
53	13 15	28 15	43 15	58 15	73 15	88 15	103 15	118 15	133 15	148 15	163 15	178 15	193 15
54	13 30	28 30	43 30	58 30	73 30	88 30	103 30	118 30	133 30	148 30	163 30	178 30	193 30
55	13 45	28 45	43 45	58 45	73 45	88 45	103 45	118 45	133 45	148 45	163 45	178 45	193 45
56	14 00	29 00	44 00	59 00	74 00	89 00	104 00	119 00	134 00	149 00	164 00	179 00	194 00
57	14 15	29 15	44 15	59 15	74 15	89 15	104 15	119 15	134 15	149 15	164 15	179 15	194 15
58	14 30	29 30	44 30	59 30	74 30	89 30	104 30	119 30	134 30	149 30	164 30	179 30	194 30
59	14 45	29 45	44 45	59 45	74 45	89 45	104 45	119 45	134 45	149 45	164 45	179 45	194 45
60	15 00	30 00	45 00	60 00	75 00	90 00	105 00	120 00	135 00	150 00	165 00	180 00	195 00

Note : To convert seconds of time , use the first column for the number of seconds and the second column for the converted value in minutes and seconds of arc ; for example 33 seconds of time = 8'15" in arc .

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CONVERSION OF ARC TO TIME

°	h	m	°	h	m	°	h	m	°	h	m	°	h	m	''	s
'	m	s	'	m	s											
0	0	00	30	2	00	60	4	00	90	6	00	120	8	00	0	0.00
1	0	04	31	2	04	61	4	04	91	6	04	121	8	04	2	0.13
2	0	08	32	2	08	62	4	08	92	6	08	122	8	08	4	0.27
3	0	12	33	2	12	63	4	12	93	6	12	123	8	12	6	0.40
4	0	16	34	2	16	64	4	16	94	6	16	124	8	16	8	0.53
5	0	20	35	2	20	65	4	20	95	6	20	125	8	20	10	0.67
6	0	24	36	2	24	66	4	24	96	6	24	126	8	24	12	0.80
7	0	28	37	2	28	67	4	28	97	6	28	127	8	28	14	0.93
8	0	32	38	2	32	68	4	32	98	6	32	128	8	32	16	1.07
9	0	36	39	2	36	69	4	36	99	6	36	129	8	36	18	1.20
10	0	40	40	2	40	70	4	40	100	6	40	130	8	40	20	1.33
11	0	44	41	2	44	71	4	44	101	6	44	131	8	44	22	1.47
12	0	48	42	2	48	72	4	48	102	6	48	132	8	48	24	1.60
13	0	52	43	2	52	73	4	52	103	6	52	133	8	52	26	1.73
14	0	56	44	2	56	74	4	56	104	6	56	134	8	56	28	1.87
15	1	00	45	3	00	75	5	00	105	7	00	135	9	00	30	2.00
16	1	04	46	3	04	76	5	04	106	7	04	136	9	04	32	2.13
17	1	08	47	3	08	77	5	08	107	7	08	137	9	08	34	2.27
18	1	12	48	3	12	78	5	12	108	7	12	138	9	12	36	2.40
19	1	16	49	3	16	79	5	16	109	7	16	139	9	16	38	2.53
20	1	20	50	3	20	80	5	20	110	7	20	140	9	20	40	2.67
21	1	24	51	3	24	81	5	24	111	7	24	141	9	24	42	2.80
22	1	28	52	3	28	82	5	28	112	7	28	142	9	28	44	2.93
23	1	32	53	3	32	83	5	32	113	7	32	143	9	32	46	3.07
24	1	36	54	3	36	84	5	36	114	7	36	144	9	36	48	3.20
25	1	40	55	3	40	85	5	40	115	7	40	145	9	40	50	3.33
26	1	44	56	3	44	86	5	44	116	7	44	146	9	44	52	3.47
27	1	48	57	3	48	87	5	48	117	7	48	147	9	48	54	3.60
28	1	52	58	3	52	88	5	52	118	7	52	148	9	52	56	3.73
29	1	56	59	3	56	89	5	56	119	7	56	149	9	56	58	3.87
30	2	00	60	4	00	90	6	00	120	8	00	150	10	00	60	4.00

Degrees of arc convert to hours and minutes of time ; minutes of arc convert to minutes and seconds of time . See right hand column for conversion of seconds of arc to seconds of time .

SIDEREAL CONVERSIONS

Longitude								
		0° 00'	2° 30'	5° 00'	7° 30'	10° 00'	12° 30'	15° 00'
Minutes								
Long.	Hours	0	10	20	30	40	50	60
°		m s	m s	m s	m s	m s	m s	m s
0	0	0 00	0 02	0 03	0 05	0 07	0 08	0 10
15	1	0 10	0 11	0 13	0 15	0 16	0 18	0 20
30	2	0 20	0 21	0 23	0 25	0 26	0 28	0 30
45	3	0 30	0 31	0 33	0 34	0 36	0 38	0 39
60	4	0 39	0 41	0 43	0 44	0 46	0 48	0 49
75	5	0 49	0 51	0 53	0 54	0 56	0 57	0 59
90	6	0 59	1 01	1 02	1 04	1 06	1 07	1 09
105	7	1 09	1 11	1 12	1 14	1 15	1 17	1 19
120	8	1 19	1 20	1 22	1 24	1 25	1 27	1 29
135	9	1 29	1 30	1 32	1 34	1 35	1 37	1 38
150	10	1 38	1 40	1 42	1 43	1 45	1 47	1 48
165	11	1 48	1 50	1 52	1 53	1 55	1 56	1 58
180	12	1 58	2 00	2 01	2 03	2 05	2 06	2 08

Sidereal into mean solar time : To be subtracted from a sidereal time interval :
Argument , hours and minutes of sidereal interval .

Mean solar into sidereal time : To be added to a mean time interval :
Argument , hours and minutes of mean time interval .

For any stellar observation : Amount to be subtracted from the Greenwich mean time
of transit or elongation to obtain local mean time :
Argument , longitude west from Greenwich ; add for
longitudes east from Greenwich .

FOR FINDING THE VERTICAL AND HORIZONTAL ANGLES OF A STAR
Natural Sines, Cosines, and Tangents

For sin tan	tan	sin	For cos only	For sin tan	tan	sin	For cos only	For sin tan	tan	sin	For cos only
0°00'	.0000	.0000	90°00'	15°00'	.2679	.2588	75°00'	30°00'	.5774	.5000	60°00'
15'	.0044	.0044	45'	15'	.2726	.2630	45'	15'	.5832	.5038	45'
30'	.0087	.0087	30'	30'	.2773	.2672	30'	30'	.5890	.5075	30'
45'	.0131	.0131	15'	45'	.2820	.2714	15'	45'	.5949	.5113	15'
1°00'	.0175	.0175	89°00'	16°00'	.2867	.2756	74°00'	31°00'	.6009	.5150	59°00'
15'	.0218	.0218	45'	15'	.2915	.2798	45'	15'	.6068	.5188	45'
30'	.0262	.0262	30'	30'	.2962	.2840	30'	30'	.6128	.5225	30'
45'	.0306	.0305	15'	45'	.3010	.2882	15'	45'	.6188	.5262	15'
2°00'	.0349	.0349	88°00'	17°00'	.3057	.2924	73°00'	32°00'	.6249	.5299	58°00'
15'	.0393	.0393	45'	15'	.3105	.2965	45'	15'	.6310	.5336	45'
30'	.0437	.0436	30'	30'	.3153	.3007	30'	30'	.6371	.5373	30'
45'	.0480	.0480	15'	45'	.3201	.3049	15'	45'	.6432	.5410	15'
3°00'	.0524	.0523	87°00'	18°00'	.3249	.3090	72°00'	33°00'	.6494	.5446	57°00'
15'	.0568	.0567	45'	15'	.3298	.3132	45'	15'	.6556	.5483	45'
30'	.0612	.0610	30'	30'	.3346	.3173	30'	30'	.6619	.5519	30'
45'	.0655	.0654	15'	45'	.3395	.3214	15'	45'	.6682	.5556	15'
4°00'	.0699	.0698	86°00'	19°00'	.3443	.3256	71°00'	34°00'	.6745	.5592	56°00'
15'	.0743	.0741	45'	15'	.3492	.3297	45'	15'	.6809	.5628	45'
30'	.0787	.0785	30'	30'	.3541	.3338	30'	30'	.6873	.5664	30'
45'	.0831	.0828	15'	45'	.3590	.3379	15'	45'	.6937	.5700	15'
5°00'	.0875	.0872	85°00'	20°00'	.3640	.3420	70°00'	35°00'	.7002	.5736	55°00'
15'	.0919	.0915	45'	15'	.3689	.3461	45'	15'	.7067	.5771	45'
30'	.0963	.0958	30'	30'	.3739	.3502	30'	30'	.7133	.5807	30'
45'	.1007	.1002	15'	45'	.3789	.3543	15'	45'	.7199	.5842	15'
6°00'	.1051	.1045	84°00'	21°00'	.3839	.3584	69°00'	36°00'	.7265	.5878	54°00'
15'	.1095	.1089	45'	15'	.3889	.3624	45'	15'	.7332	.5913	45'
30'	.1139	.1132	30'	30'	.3939	.3665	30'	30'	.7400	.5948	30'
45'	.1184	.1175	15'	45'	.3990	.3706	15'	45'	.7467	.5983	15'
7°00'	.1228	.1219	83°00'	22°00'	.4040	.3746	68°00'	37°00'	.7536	.6018	53°00'
15'	.1272	.1262	45'	15'	.4091	.3786	45'	15'	.7604	.6053	45'
30'	.1317	.1305	30'	30'	.4142	.3827	30'	30'	.7673	.6088	30'
45'	.1361	.1349	15'	45'	.4193	.3867	15'	45'	.7743	.6122	15'
8°00'	.1405	.1392	82°00'	23°00'	.4245	.3907	67°00'	38°00'	.7813	.6157	52°00'
15'	.1450	.1435	45'	15'	.4296	.3947	45'	15'	.7883	.6191	45'
30'	.1495	.1478	30'	30'	.4348	.3987	30'	30'	.7954	.6225	30'
45'	.1539	.1521	15'	45'	.4400	.4027	15'	45'	.8026	.6259	15'
9°00'	.1584	.1564	81°00'	24°00'	.4452	.4067	66°00'	39°00'	.8098	.6293	51°00'
15'	.1629	.1607	45'	15'	.4505	.4107	45'	15'	.8170	.6327	45'
30'	.1673	.1650	30'	30'	.4557	.4147	30'	30'	.8243	.6361	30'
45'	.1718	.1693	15'	45'	.4610	.4187	15'	45'	.8317	.6394	15'
10°00'	.1763	.1736	80°00'	25°00'	.4663	.4226	65°00'	40°00'	.8391	.6428	50°00'
15'	.1808	.1779	45'	15'	.4716	.4266	45'	15'	.8466	.6461	45'
30'	.1853	.1822	30'	30'	.4770	.4305	30'	30'	.8541	.6494	30'
45'	.1899	.1865	15'	45'	.4823	.4344	15'	45'	.8617	.6528	15'
11°00'	.1944	.1908	79°00'	26°00'	.4877	.4384	64°00'	41°00'	.8693	.6561	49°00'
15'	.1989	.1951	45'	15'	.4931	.4423	45'	15'	.8770	.6593	45'
30'	.2035	.1994	30'	30'	.4986	.4462	30'	30'	.8847	.6626	30'
45'	.2080	.2036	15'	45'	.5040	.4501	15'	45'	.8925	.6659	15'
12°00'	.2126	.2079	78°00'	27°00'	.5095	.4540	63°00'	42°00'	.9004	.6691	48°00'
15'	.2171	.2122	45'	15'	.5150	.4579	45'	15'	.9083	.6724	45'
30'	.2217	.2164	30'	30'	.5206	.4617	30'	30'	.9163	.6756	30'
45'	.2263	.2207	15'	45'	.5261	.4656	15'	45'	.9244	.6788	15'
13°00'	.2309	.2250	77°00'	28°00'	.5317	.4695	62°00'	43°00'	.9325	.6820	47°00'
15'	.2355	.2292	45'	15'	.5373	.4733	45'	15'	.9407	.6852	45'
30'	.2401	.2334	30'	30'	.5430	.4772	30'	30'	.9490	.6884	30'
45'	.2447	.2377	15'	45'	.5486	.4810	15'	45'	.9573	.6915	15'
14°00'	.2493	.2419	76°00'	29°00'	.5543	.4848	61°00'	44°00'	.9657	.6947	46°00'
15'	.2540	.2462	45'	15'	.5600	.4886	45'	15'	.9742	.6978	45'
30'	.2586	.2504	30'	30'	.5658	.4924	30'	30'	.9827	.7009	30'
45'	.2633	.2546	15'	45'	.5715	.4962	15'	45'	.9913	.7040	15'
15°00'	.2679	.2588	75°00'	30°00'	.5774	.5000	60°00'	45°00'	1.0000	.7071	45°00'
For sin tan	tan	cos	For cos only	For sin tan	tan	cos	For cos only	For sin tan	tan	cos	For cos only

On the meridian, the vertical angle: $h = 90^\circ - \phi \pm \delta$

At any hour angle: $\sin h = \cos t \cos \phi \cos \delta + \sin \phi \sin \delta$

The product: " $\sin \phi \sin \delta$ " is negative for south declinations.

The product: " $\cos t \cos \phi \cos \delta$ " is negative for hour angles exceeding six hours or 90° .

FOR FINDING THE VERTICAL AND HORIZONTAL ANGLES OF A STAR
Natural Sines, Cosines, and Tangents

For sin tan	tan	sin	For cos only	For sin tan	tan	sin	For cos only	For sin	sin	For cos only
45°00'	1.0000 88	.7071 31	45°00'	60°00'	1.7321 175	.8660 22	30°00'	75°00'	.9659 11	15°00'
15'	1.0088 88	.7102 31	45'	15'	1.7496 179	.8682 22	45'	15'	.9670 11	45'
30'	1.0176 89	.7133 30	30'	30'	1.7675 181	.8704 21	30'	30'	.9681 11	30'
45'	1.0265 90	.7163 30	15'	45'	1.7856 184	.8725 21	15'	45'	.9692 11	15'
46°00'	1.0355 91	.7193 31	44°00'	61°00'	1.8040 188	.8746 21	29°00'	76°00'	.9703 10	14°00'
15'	1.0446 92	.7224 30	45'	15'	1.8228 190	.8767 21	45'	15'	.9713 11	45'
30'	1.0538 92	.7254 30	30'	30'	1.8418 193	.8788 21	30'	30'	.9724 10	30'
45'	1.0630 94	.7284 30	15'	45'	1.8611 196	.8809 20	15'	45'	.9734 10	15'
47°00'	1.0724 94	.7314 29	43°00'	62°00'	1.8807 200	.8829 21	28°00'	77°00'	.9744 9	13°00'
15'	1.0818 95	.7343 30	45'	15'	1.9007 203	.8850 20	45'	15'	.9753 10	45'
30'	1.0913 96	.7373 29	30'	30'	1.9210 206	.8870 20	30'	30'	.9763 9	30'
45'	1.1009 97	.7402 29	15'	45'	1.9416 210	.8890 20	15'	45'	.9772 9	15'
48°00'	1.1106 98	.7431 30	42°00'	63°00'	1.9626 214	.8910 20	27°00'	78°00'	.9781 9	12°00'
15'	1.1204 99	.7461 29	45'	15'	1.9840 217	.8930 19	45'	15'	.9790 9	45'
30'	1.1303 100	.7490 28	30'	30'	2.0057 221	.8949 20	30'	30'	.9799 9	30'
45'	1.1403 101	.7518 29	15'	45'	2.0278 225	.8969 19	15'	45'	.9808 8	15'
49°00'	1.1504 102	.7547 29	41°00'	64°00'	2.0503 229	.8988 19	26°00'	79°00'	.9816 9	11°00'
15'	1.1606 102	.7576 28	45'	15'	2.0732 233	.9007 19	45'	15'	.9825 8	45'
30'	1.1708 104	.7604 28	30'	30'	2.0965 238	.9026 19	30'	30'	.9833 7	30'
45'	1.1812 106	.7632 28	15'	45'	2.1203 242	.9045 18	15'	45'	.9840 8	15'
50°00'	1.1918 106	.7660 28	40°00'	65°00'	2.1445 247	.9063 18	25°00'	80°00'	.9848 8	10°00'
15'	1.2024 107	.7688 28	45'	15'	2.1692 251	.9081 19	45'	15'	.9856 7	45'
30'	1.2131 108	.7716 28	30'	30'	2.1943 256	.9100 18	30'	30'	.9863 7	30'
45'	1.2239 110	.7744 27	15'	45'	2.2199 261	.9118 17	15'	45'	.9870 7	15'
51°00'	1.2349 111	.7771 28	39°00'	66°00'	2.2460 267	.9135 18	24°00'	81°00'	.9877 7	9°00'
15'	1.2460 112	.7799 27	45'	15'	2.2727 271	.9153 18	45'	15'	.9884 6	45'
30'	1.2572 113	.7826 27	30'	30'	2.2998 278	.9171 17	30'	30'	.9890 7	30'
45'	1.2685 114	.7853 27	15'	45'	2.3276 283	.9188 17	15'	45'	.9897 6	15'
52°00'	1.2799 116	.7880 27	38°00'	67°00'	2.3559 288	.9205 17	23°00'	82°00'	.9903 6	8°00'
15'	1.2915 117	.7907 27	45'	15'	2.3847 295	.9222 17	45'	15'	.9909 5	45'
30'	1.3032 119	.7934 26	30'	30'	2.4142 301	.9239 16	30'	30'	.9914 5	30'
45'	1.3151 119	.7960 26	15'	45'	2.4443 308	.9255 17	15'	45'	.9920 5	15'
53°00'	1.3270 122	.7986 27	37°00'	68°00'	2.4751 314	.9272 16	22°00'	83°00'	.9925 6	7°00'
15'	1.3392 122	.8013 26	45'	15'	2.5065 321	.9288 16	45'	15'	.9931 5	45'
30'	1.3514 124	.8039 25	30'	30'	2.5386 329	.9304 16	30'	30'	.9936 5	30'
45'	1.3638 126	.8064 26	15'	45'	2.5715 336	.9320 16	15'	45'	.9941 4	15'
54°00'	1.3764 127	.8090 26	36°00'	69°00'	2.6051 344	.9336 15	21°00'	84°00'	.9945 5	6°00'
15'	1.3891 128	.8116 25	45'	15'	2.6395 351	.9351 16	45'	15'	.9950 4	45'
30'	1.4019 131	.8141 25	30'	30'	2.6746 360	.9367 15	30'	30'	.9954 4	30'
45'	1.4150 131	.8166 26	15'	45'	2.7106 369	.9382 15	15'	45'	.9958 4	15'
55°00'	1.4281 134	.8192 24	35°00'	70°00'	2.7475 377	.9397 15	20°00'	85°00'	.9962 4	5°00'
15'	1.4415 135	.8216 25	45'	15'	2.7852 387	.9412 14	45'	15'	.9966 3	45'
30'	1.4550 137	.8241 25	30'	30'	2.8239 397	.9426 15	30'	30'	.9969 4	30'
45'	1.4687 139	.8266 24	15'	45'	2.8636 406	.9441 14	15'	45'	.9973 3	15'
56°00'	1.4826 140	.8290 25	34°00'	71°00'	2.9042 417	.9455 14	19°00'	86°00'	.9976 3	4°00'
15'	1.4966 142	.8315 24	45'	15'	2.9459 428	.9469 14	45'	15'	.9979 2	45'
30'	1.5108 145	.8339 24	30'	30'	2.9887 439	.9483 14	30'	30'	.9981 3	30'
45'	1.5253 146	.8363 24	15'	45'	3.0326 451	.9497 14	15'	45'	.9984 2	15'
57°00'	1.5399 148	.8387 23	33°00'	72°00'	3.0777 463	.9511 13	18°00'	87°00'	.9986 2	3°00'
15'	1.5547 150	.8410 24	45'	15'	3.1240 476	.9524 13	45'	15'	.9988 2	45'
30'	1.5697 152	.8434 23	30'	30'	3.1716 489	.9537 13	30'	30'	.9990 2	30'
45'	1.5849 154	.8457 23	15'	45'	3.2205 504	.9550 13	15'	45'	.9992 2	15'
58°00'	1.6003 157	.8480 24	32°00'	73°00'	3.2709 517	.9563 13	17°00'	88°00'	.9994 1	2°00'
15'	1.6160 159	.8504 22	45'	15'	3.3226 533	.9576 12	45'	15'	.9995 2	45'
30'	1.6319 160	.8526 23	30'	30'	3.3759 549	.9588 12	30'	30'	.9997 1	30'
45'	1.6479 164	.8549 23	15'	45'	3.4308 566	.9600 13	15'	45'	.9998 0	15'
59°00'	1.6643 165	.8572 22	31°00'	74°00'	3.4874 583	.9613 12	16°00'	89°00'	.9998 1	1°00'
15'	1.6808 169	.8594 22	45'	15'	3.5457 602	.9625 11	45'	15'	.9999 1	45'
30'	1.6977 170	.8616 22	30'	30'	3.6059 621	.9636 12	30'	30'	1.0000 0	30'
45'	1.7147 174	.8638 22	15'	45'	3.6680 641	.9648 11	15'	45'	1.0000 0	15'
60°00'	1.7321	.8660	30°00'	75°00'	3.7321	.9659	15°00'	90°00'	1.0000	0°00'
For sin tan	tan	cos	For cos only	For sin tan	tan	cos	For cos only	For sin	cos	For cos only

The horizontal angle may be found from the equation: $\cos A = \frac{\sin \delta}{\cos \phi \cos h} - \tan \phi \tan h$

"Sin δ " is negative for south declinations.

If the result for "cos A" is {positive} the horizontal angle counts from the {north.
negative} south.

PREPARING FOR THE OBSERVATIONS

The modern solar transit, as developed for surveying the public lands, affords a ready determination of the factors of time, latitude, and azimuth, which are the starting values employed in the stellar observations. The latter are designed to supply the desired refinements in the values, better than the limits of the solar unit. A carefully determined meridian is used in making the instrumental adjustments and tests, preliminary to the running of the lines, and the direction of the latter is verified at frequent intervals.

Since few solar transits are in general use, consideration is to be given to the preliminary steps to be taken when the factors of time, latitude, and azimuth are unknown, or are only roughly approximate. If nothing is to be assumed as known, or approximate, it is well to begin with the equal-altitude observation on the sun, or one of the known bright stars, by which the latitude, azimuth, and time may all be derived.

If the uncertainty in latitude is not more than 2' or 3', an altitude observation of the sun, or any known bright star, may be made, from which to derive preliminary values for time and azimuth, using the approximate latitude as the factor until its value can be suitably corrected. An observation of Polaris at elongation may be made without exact data as to the time or latitude.

An interpretation of the terms "approximate" and "rough" may be helpful in clarifying what is intended. These terms have been used with reference to the preliminary values for time, latitude, and azimuth, to be regarded as more or less reliable for the identification of a star by vertical and horizontal angles. For this purpose and for a starlight period, a rough estimate based upon incomplete data, employed with good judgment, may allow a fairly wide tolerance and yet be entirely acceptable for the identification of a star without the slightest doubt. However, if a daylight or twilight observing period is proposed the setting positions should be sufficiently good to bring the star within the middle-third of the telescope. The time of passage across the field is slightly more than 4 minutes.

Some practice in making the observations by starlight is needed, or will be helpful, before making the twilight or daylight observations, and for the latter it is desirable to prepare the data for several positions for the sequence of settings at intervals that will allow for the reading of angles and the instrumental reversals. Obviously, the twilight or daylight observation will depend very largely upon the clearness of the atmosphere.

In all cases the finding positions are for the identification of a star, and having served that purpose the observation proceeds with the required care in all detail. The arrangement of the data and the suggestions as to the observing plan are intended to simplify the steps. The methods for a well-balanced observing program are good for results within ± 6 seconds of time; $\pm 15''$ in latitude and azimuth; for vernier readings to the nearest 30''; due care being given to the necessary refinements in the observing and in the reductions; these limits are with reference to the one-minute transit ordinarily supplied to the field parties.

The setting positions for the instrument, in vertical angle (v or h for this purpose), and in horizontal angle (A) counting from the meridian (or from an approximate north and south line) are derived from the equations after having determined the hour angle (t) for the anticipated moment for the observation.

The 4-place tables may be used to shorten the work, as being sufficient for the star's identification or finding.

Example.

Star: 6-10 1.1
 α Tauri (Aldebaran)

δ : $+16^\circ 28'$

$$\sin h = \cos t \cos \varphi \cos \delta + \sin \varphi \sin \delta$$

	<u>cos</u>	<u>sin</u>
$t = .330$		
$\varphi = .816$	.578	
$\delta = .959$	.283	
	.2582	.1636 (Products)
		<u>.2582</u>
$\sin h =$	.4218 (Sum)	
$h = 24^\circ 57'$		

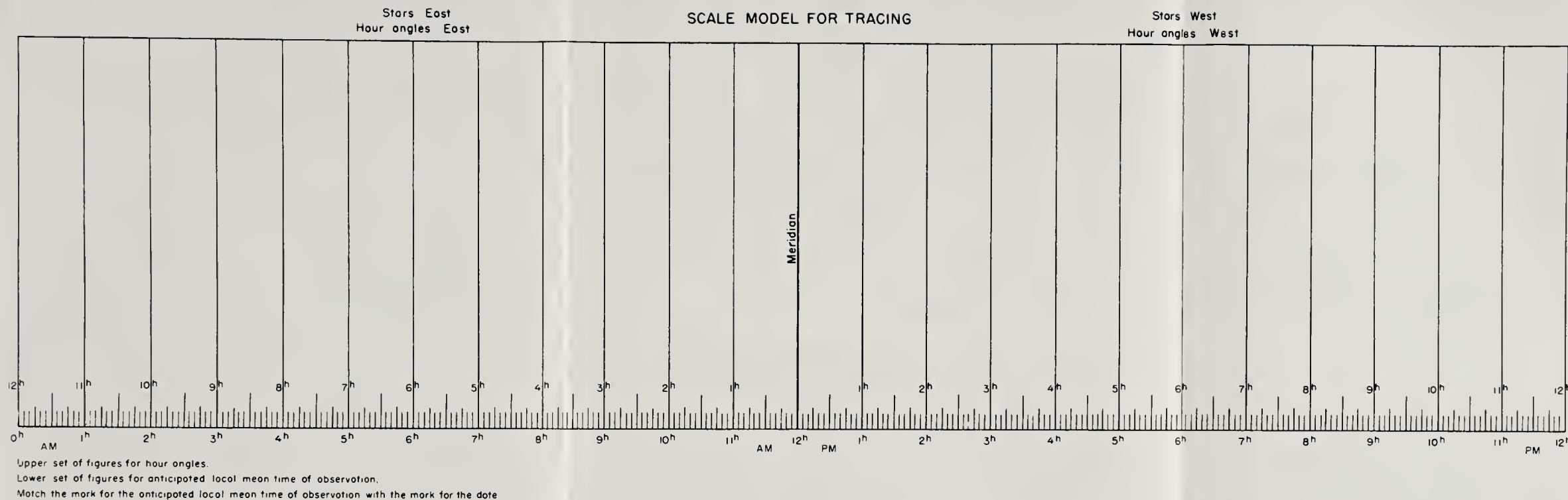
φ : Approximate latitude: $35^\circ 18'$

t : Anticipated hour angle: $4^h 43^m$ ($70^\circ 45'$)

$$\cos A = \frac{\sin \delta}{\cos \varphi \cos h} - \tan \varphi \tan h$$

<u>cos</u>	<u>sin</u>	<u>tan</u>
.816		.708
	.283	
.907		.465
.7401		.3292 (Products)
	.3824	<u>.3824</u> (Fraction)
$\cos A =$		.0532 (Diff. +)
$A = 86^\circ 57'$		(Counting from the north)

In general make each reading to the nearest third place, regarding the values as merely approximate. The results are good as finding positions, or for the star's identification. The true values are obtained by careful reduction of the observations.



THE STAR CHART

The chart visualizes the positions of the selected stars. The right ascension is expressed in hours of sidereal time, from west to east, counting from the point where the path of the sun in its northward course in declination crosses the equator. The point is termed the vernal equinox.

The sidereal day of 24 hours is approximately 4 minutes shorter than the ordinary mean solar day; a star will cross the meridian approximately 4 minutes earlier each succeeding day; on one calendar day each year a star will have a double meridian passage.

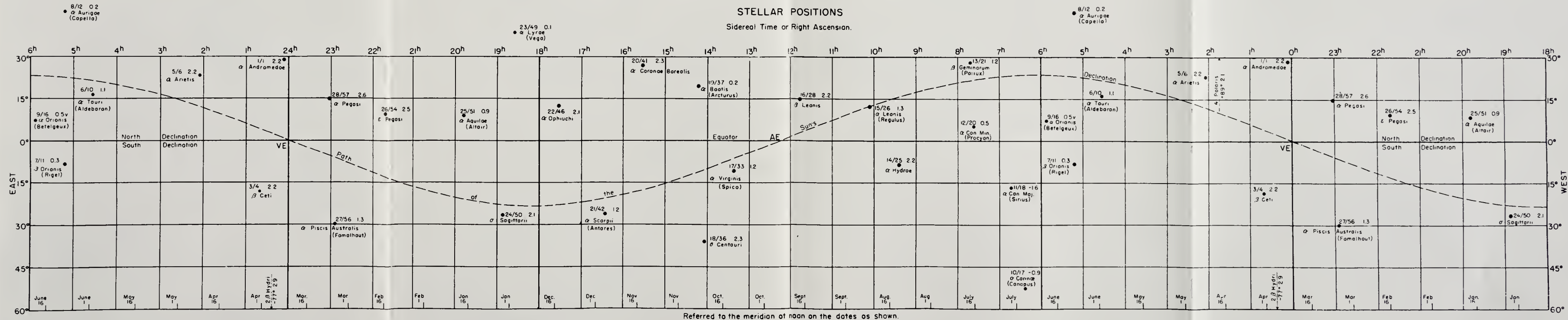
The chart is to be oriented facing south. The center of the field at noon on any date may be interpolated (roughly) between the marks for the dates as indicated. At 6 p. m., local mean time, the center of the field, or line for the meridian, will be six hours to the left; at 8 p. m., 8 hours to the left; both counting from the point for the noon of the date.

The interval between the time of a star's meridian passage and any other position in its diurnal circle is the star's sidereal hour angle, at the moment, and may count either to the east or to the west.

Anticipating the local mean time of an observation, a star's hour angle, at that moment, may be scaled (roughly) according to its position on the diagram to the east or to the west of the line for the meridian as placed for that date and time.

The calculations for the reduction of an observation are to be based upon the exact local mean time of the star's meridian passage for the date as ascertained from the tabulated data, from which the sidereal interval, or hour angle at the moment of the observation, may be derived, and the latter converted into the equivalent mean time interval.

It may be noted that the time factor does not enter into the equation for azimuth in the reduction of an altitude observation.



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